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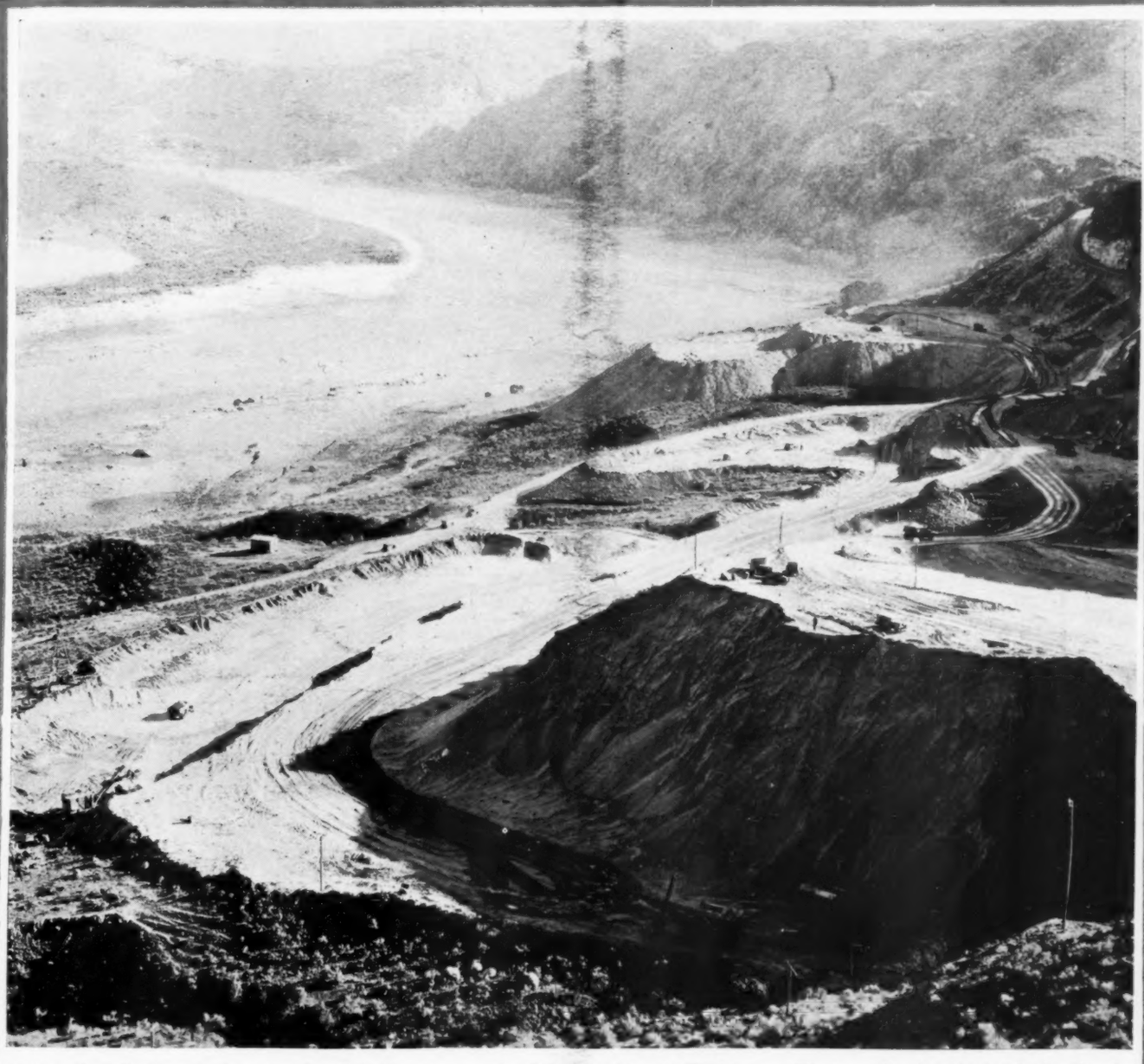

A view of preliminary work at the Grand Coulee Dam on the Columbia River in Washington. Work on this $63,000,000 hydro-electric power project, financed by PWA, now is well under way. The dam, which will create a reservoir 50 miles in length, is being built under supervision of the Bureau of Reclamation, Interior Department.

AUGUST, 1934

STATE HIGHWAY NEAR BENNINGTON, VT.—SOCONY ASPHALT CUT-BACK, MIXED IN PLACE METHOD

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VOL. 65 PUBLIC WORKS No. 8
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AUGUST 1934

August 1934

PUBLIC WORKS

Vol. 65 No. 8

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

TABLE OF CONTENTS FOR AUGUST, 1934

TIMEWASTERS

New *timewasters* and solutions of old ones pursued *ye editor* of this column to camp the early part of July, and when the second louies become too much of a problem, he set them to work on the TWs. As a result——

Help Wanted!

A hollow pyramid is to be built of 4-inch timber. It is to be 4 feet square at the bottom, and the sides slope at 45° angles. At what angle must the edges of the timbers be beveled so as to fit perfectly along the intersections of the sides? At what angles if the side slope is 60°? *W.A.H.*

Sort of Easy:

Take one large square and divide into nine small squares. Using the first nine digits, arrange them in the small squares (only one in each) so that the sum of each vertical line, each horizontal line and each diagonal line will add up to 15. *A. A. Merrill, Cresco, Ia.*

Preparedness:

A number of cannon balls piled in a square based pyramid is rearranged to form two triangle based pyramids. The number of balls in the perimeter of the base of the larger new pyramid is an even dozen less than in the perimeter of the base of the original pyramid. How many balls are there? B. F.

Solutions:

Of course, the wire stretched around the earth 6 feet from the equator would be 6 x 3.1416 greater in circumference than the earth, or about 19 feet. The hill-billy worrying matter was a small one after all, but it still isn't settled. Bob Clark says the wire must be 1/800 of an inch longer, whereas Benjamin Eisner says it need be only 1/600 of an inch longer. They aren't far apart, but we hope they get closer. They were the only ones to submit answers, so far, to this problem. If Mr. Brady's clock is still running, the hands will pass this afternoon at precisely 3:16:21.-8181818181818. . . . The solution for the table of logs is too long to reproduce here, but we will give it and other solutions, including the hill-billy problem next month, arrangements having been made whereby *Timewasters* will have a little extra space to strut its stuff.

Editorial Note:

So many interesting letters and comments are received that we feel keenly our inability to publish many of them. Next month we shall have more space available. In the meantime, we should be glad to have Don Hastings' solution to the trisection of an angle, if he can locate it. And we thank the many readers who contribute to this column for their interest and we apologize for the fact that we cannot always either acknowledge all the problems and solutions received, nor publish here the names of more than a few of our faithful.—*W.A.H.*

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A. PRESCOTT FOLWELL, *Editor* W. A. HARDENBERGH, *Asso. Editor*

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 65 *August, 1934* No. 8

On the left, road failure due to insufficient internal friction in the road material; on the right, a poor road because sand lacks cohesion.

Stability of Soils Depends Upon Shear Strength

Third of a series of articles on the utilization of soil analysis in economic highway construction.

By the Division of Tests, U. S. Bureau of Public Roads
Reported by C. A. Hogentogler, Senior Highway Engineer

DEFLECTIONS of the subgrade due to traffic on the pavement, and volume changes of the subgrade soil due to causes independent of traffic, are the two sets of influences responsible for structural failures of road surfaces.

Lateral flow, compression, and elasticity account for the deflections of the subgrade due to load; shrinkage, swell, and frost heave for those independent of load.

Major failures of the type illustrated in Fig. 1 are due to lateral flow. The resistance to lateral flow, defined as stability, depends upon the shear strength of the soil along certain sliding surfaces.

To illustrate, assume a soil to be loaded for an indefinite length over a width of 2 b as shown in Fig. 2-A. In order that settlement due to lateral flow can occur, the section of soil, A, beneath the load must shear along some plane such as S and displace laterally as indicated in figure 2-B. But for this to occur, the adjacent section of earth "C" must shear along some surface such as S′ and thus displace upwards forming a bulge adjacent to the loaded area as shown in figure 2-C.

Actually, the surfaces S and S′ may be parts of a continuously curved surface, but for the purpose of mathematical treatment they may be considered as separate plane surfaces without introducing a prohibitive error.

For the soil to remain stable, the earth prism C must resist displacement sufficiently to prevent the lateral bulging of the prism A.

The shear strength of the soil along the assumed plane S′, which must be exceeded by the tendency of the prism C to slide, before the soil can displace, is the combined effect of the two mechanical properties, internal friction and cohesion.

Internal friction is the resistance of soil particles to sliding over each other. It is furnished by the granular fraction of the soil, and its magnitude is designated by the expression

$$N \tan \phi,$$

in which, N is the component of the weight of the soil acting perpendicular to the shear plane, and

ϕ is the angle of internal friction, which is the angle of repose of cohesionless soils

Tan ϕ is termed the coefficient of internal friction, and designated by the letter f.

Cohesion is the result of the stickiness or cohesiveness of the soil particles. It is furnished by asphalts and tars in bituminous surfaces; by colloidal clays and moisture films in top-soil, sand-clay and similar light-textured soils; and by moisture films alone in beaches stabilized temporarily by the tide. Cohesion is designated by the letter c and is expressed as grams per

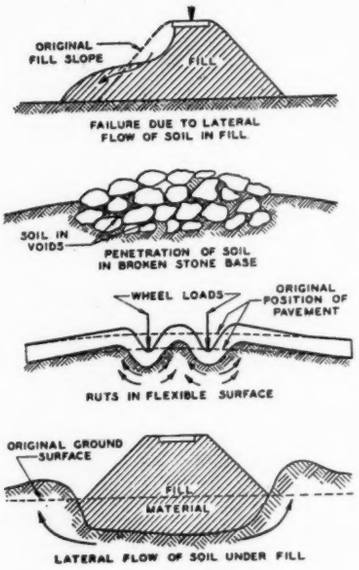


FIG. 1

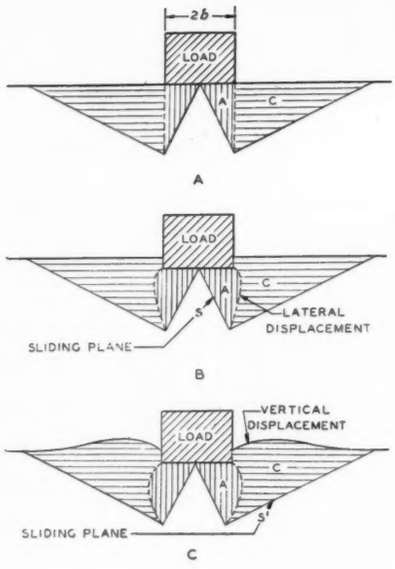


FIG. 2

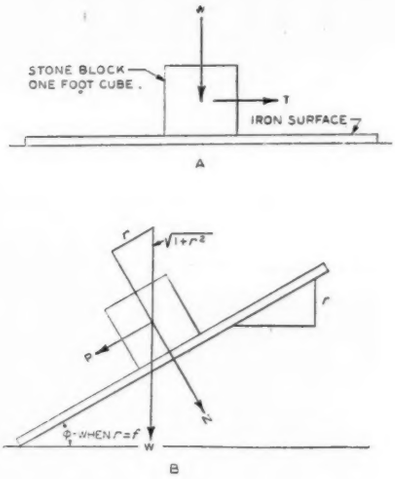


FIG. 3

square centimeter, pounds per square foot, etc.

The total shear resistance, T, is designated by the basic formula

$$T = N \tan \phi + c \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1)$$

Internal Friction Increases with Increase of Pressure Acting on the Sliding Plane

A one-foot cube of stone on an iron surface (Fig. 3-A) may be used to illustrate the effect of internal friction. So long as the surface remains horizontal the entire weight of the block acts perpendicular to the surface to prevent the block from sliding. Here the force T which corresponds to the shear resistance mentioned above becomes Wf in which f is the coefficient of friction and corresponds to the coefficient of internal friction of soils also mentioned above.

When the iron surface is tilted, as in Fig. 3-B, one component, N, of the weight of the block acts perpendicular to the surface to resist, and another component acts parallel to the surface to cause sliding of the block. At any slope of the surface, indicated by a vertical rise, r, in a horizontal distance of unity.

$$N = \frac{1}{\sqrt{1 + r^2}} W$$

$$P = \frac{r}{\sqrt{1 + r^2}} W$$

The force, T, corresponding to the shear strength mentioned above, but which resists sliding in this case equals

$$Nf = Wf \frac{1}{\sqrt{1 + r^2}}$$

As the slope of the iron surface increases, the force productive of sliding increases and the resistances to sliding decreases until finally a value of r is reached at which P becomes equal to T and the block begins to slide. This value of r is the coefficient of friction, f, and also the tangent of the angle ϕ which the inclined plane makes with the horizontal at this time.

According to the Smithsonian tables, the stone block should begin to slide when the iron surface reaches a slope designated by an r of about 0.30 (ϕ about 17°). At an average density of 2.70 for the rock, W becomes 168.5 pounds and with the iron plane horizontal.

$$T = 0.30 \times 168.5 = 50.6 \text{ pounds}$$

If the stone block were reduced in height until its weight equaled that of a cubic foot of oak, say 44 pounds, T would equal

$$0.30 \times 44 = 13.2 \text{ pounds.}$$

If on the other hand the stone block were loaded until its weight became equal to that of a cubic foot of steel, say 475 pounds, T would equal about 143 pounds.

Angle of Friction Increases with Increase in the Roughness of the Sliding Plane

If the weight of the stone block is kept constant at 168.5 pounds and the iron surface roughened, the slope at which sliding occurs may be increased until r equals as much as 0.70 (ϕ about 35°). On the other hand, lubricating the surfaces could cause the block to slide on a slope with r as small as 0.10 (ϕ about 6°). In the first case T becomes 118 pounds and in the second, 17 pounds.

Thus the force required to slide blocks having the same coefficient of friction, f, varies with their weight. That required to slide blocks of the same weight varies with the slope of the inclined plane at which the blocks begin to slide.

Theoretical Essentials of Soil Stability

Like the resistance of the stone blocks to sliding, the stability of cohesionless granular materials depends upon their weight and the roughness of their sliding surface. In such soils the entire shear strength along the sliding plane, Fig. 2, is furnished by internal friction.

Theory presented by Terzaghi (*Public Roads*, May, 1929) suggests that in such cases the unit load q which the soil will just support without displacing laterally; the unit weight of the soil, s; the width of the loaded area, $2b$; and the angle of internal friction ϕ are mathematically related as follows:

$$q = \frac{bs\ (1 - \tan^4 B)}{2 \tan^5 B}$$

in which

$$B = 45° - \frac{\phi}{2}$$

According to this equation, the stability varies directly as the width of the loaded areas and the weight of the soil.

Since the pressure of the prism of earth C upon the sliding plane S′ is a controlling factor of stability, increasing this pressure by means of a surcharge, q_1 on top of this prism, as shown in Fig. 4, serves in turn to increase the stability q. This increase is designated by a new term which causes the formula now to become

$$q = \frac{b\,s\,(1 - \tan^4 B)}{2\tan^5 B} + \frac{q_1}{\tan^4 B}$$

The essential feature of a test for internal friction is the measurement of the lateral pressure L produced by loading a soil sample with a vertical load W. In such case

$$\frac{L}{W} = \tan^2 (45° - \frac{\phi}{2}) \quad \text{.....2)*}$$

The Cohesion Component of Shear Strength

To illustrate the manner in which cohesion supplements internal friction in furnishing stability, reference is again made to the stone block on the iron surface.

Assume that the block which slides when r equals 0.30 is to be kept from sliding until r exceeds 1.42 by means of glue applied to the iron base. The strength of this glue, or cohesion, is computed as follows:

The total force P productive of sliding is

$$168.5 \times \frac{1.42}{\sqrt{1 + 1.42^2}} = 0.82 \times 168.5 = 138.2 \text{ pounds.}$$

The frictional force preventive of sliding is

$$168.5 \times \frac{1}{\sqrt{1 + 1.42^2}} \times 0.3 = 29.3 \text{ pounds.}$$

The difference, or

$$138.2 - 29.3 = 108.9 \text{ pounds per square foot}$$

is the required cohesion.

Cohesion is not affected by the pressure on the sliding plane nor the weight of the soil. It equals the shear resistance under the theoretical condition that the angle ϕ is 0. The essential feature of a shear test is the measurement of the force T required to shear a soil sample

*See Proc. A.S.C.E. May 1933, p. 850.

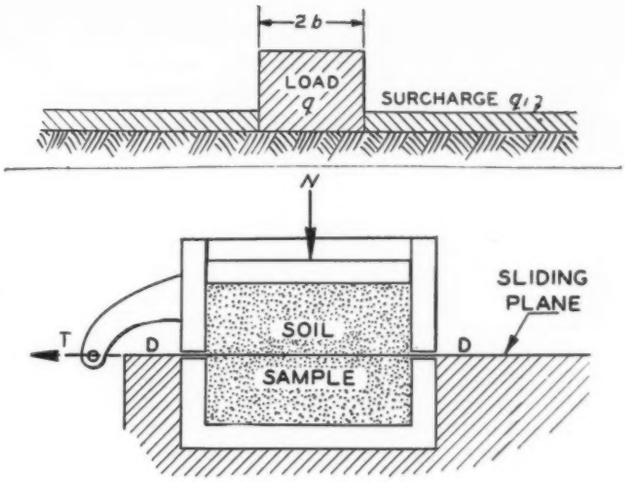


FIG. 4, *above, and* FIG. 5

such as shown in Fig. 5 at different values of the normal pressure N. A curve of the relationship between T and N extended back to N = O discloses the cohesion c of the sample.

The amount of cohesion required to increase the angle of repose of soils beyond the angle of internal friction ϕ and the stability of soils above that furnished by the granular particles alone can also be determined. The latter is accomplished by means of a third term added to the stability formula, which now becomes

$$q = \frac{b\,s\,(1 - \tan^4 B)}{2\tan^5 B} + \frac{q_1}{\tan^4 B} + \frac{2c}{\tan B \sin^2 B} \quad \text{.....3)}$$

Stability Is Influenced by a Number of Variables

By substitution of numerical values in the stability formula some conception of the relative influence of the more important road surface variables can be obtained. The approximate results of such computations are shown in Table 1.

For the conditions designated in this table, the effect of increasing $\phi = 10°$ of the silt to $\phi = 34°$ of the sand effects an increase of stability per square foot from 15 pounds to 270 pounds. The effect of immersing the dry sand and thereby reducing its effective weight per cubic foot from 100 pounds to 63 pounds, is to reduce q from 270 pounds to 170 pounds.

Increasing the width of load distribution on the cohesionless sand ten times increases the stability from 270 pounds to 2,710 pounds per square foot. Surcharg-

TABLE 1.—*Influence of internal friction, cohesion, width of loaded area and load adjacent to the loaded area upon the stability of soils.*

Soil types	Cohesion, C	Angle of internal friction, Φ	Supporting value, q			Cohesion C, to compensate for	
			$q_1 = 0$ $s = 100$ $b = 0.25$ foot	$q_1 = 100$ $s = 100$ $b = 0.25$ foot	$q_1 = 0$ $s = 100$ $b = 2.5$ feet	$q_1 = 100$	$b = 2.5$ feet
	Lb. per sq. ft.	Degrees	Lb. per sq. ft.	Lb. per sq. ft.	Lb. per sq. ft.	Lb. per sq. ft.	Lb. per sq. ft.
Silts, wet	0	10	15	220	150	35	25
Sands, dry	0	34	270	1,520	2,710	75	145
Sands, immersed (s = 63)	0	34	170	1,420	1,710	75	90
Clay, liquid	100	0	400	500	400		
Clay, very soft	200	2	860	980	880		
Clay, soft	400	4	1,850	1,980	1,890		
Clay, fairly stiff	1,000	6	4,970	5,120	5,030		
Clay, very stiff	2,000	12	12,490	12,720	12,680		
Cemented sand and gravel, wet	500	34	8,800	10,060	11,240		
Cemented sand and gravel	1,000	34	17,340	18,590	19,770		

ing the sand adjacent to the load with 100 pounds per square foot, which is approximately equivalent to the weight of a pavement 8 inches thick, increases q from 270 pounds to 1,520 pounds per cubic foot.

The stability of clays may be increased enormously by reducing their moisture contents or by admixtures of sand; and that of sand by admixtures of clay.

When the cohesion equals 1,000 pounds per square foot, b equals 0.25 foot, and q_1 equals 0, the supporting value q will equal either 4,970 or 17,340 pounds per square foot, depending on whether ϕ equals 6° or 34°. When ϕ equals 34°, q will equal 270, 8,800, or 17,340 pounds per square foot, depending on whether c equals 0, 500, or 1,000 pounds per square foot.

It is especially interesting to note from Table 1 the small amounts of cohesion required to increase the stability of cohesionless materials in amounts comparable to those due to increased load and surcharge.

In the silt with ϕ equal to 10, c equal to but 35 pounds per square foot is needed to raise q from 15 to 220 pounds, the increase effected by a surcharge q_1 of 100 pounds; and c equal to but 25 pounds is needed to raise q the amount effected by a tenfold increase in the width of the loaded area.

These examples show not only that stability depends upon both the internal friction and the cohesion of the soil but also that the manner in which stability is influenced by the size of the loaded area and the surcharge differs widely, depending on whether the stability is furnished principally by internal friction or cohesion. Thus:

1. Increasing the width of the loaded area and also surcharging the soil with a load adjacent to the loaded area increases the unit support very appreciably only when the stability is furnished principally by internal friction instead of cohesion.
2. But relatively small amounts of cohesion introduced into cohesionless soils are required to furnish increases in unit support comparable with those due to increased bearing area and weight of surcharge.
3. Admixtures which serve to prevent the soil from taking up moisture serve to prevent the soil from losing cohesion and therefore should serve to increase the stability of clays when used either as binders or subgrades.
4. Admixtures having cohesion should serve to increase the cohesion naturally possessed by the soil. Such admixtures should serve to increase (a) the stability of cohesionless silts when used as binders or subgrades and (b) the stability of sands when used as subgrades.
5. Granular materials with high resistance to sliding used as admixtures are apt to be better stabilizers than materials with relatively small resistance to sliding.

Courtesy U. S. Bureau of Public Roads

A properly constructed soil road.

Study of Kerosene Signal Torches

Due to the greater demand for using kerosene signal torches by the Ohio Department of Highways, Director of Highways O. W. Merrell requested that a study of this equipment be made by the State Highway Testing Laboratory and a specification be prepared for it.

After a preliminary study the following factors were considered pertinent to the proper performance of a torch:

Length of time of burning.
Ability to withstand high wind velocities.
Ability to burn in certain degrees of rainfall.
Be self righting.

In determining the burning time of the several different makes of torches under test, the wicks of each were trimmed to the same height, the torches filled with kerosene and allowed to burn until empty. Burning time varied from 9 to 72 hours, depending upon the capacity of the torch and the type of burner employed.

The wind tunnel used was capable of developing wind velocities of from 10 to 60 miles per hour. It was found that the position of the burner in relation to the direction of the wind determined to a large extent the suitability of a torch. For example, one torch which burned 20 minutes in a 47 m.p.h. wind when in a favorable position would only burn 2 minutes in an 18 m.p.h. wind in an unfavorable position. A torch to be satisfactory must be capable of burning in a wind blowing from any direction.

An artificial rainfall was produced by using a fine spray nozzle connected with a constant supply of water. A pan was used to measure the actual amount of water falling during a given time interval. The six torches were burned for ten minutes as a warm-up period, then placed under the spray for 15 minutes. If a torch was extinguished during that time it did not pass the test for that particular rate of rainfall. At the end of 15 minutes the spray was turned off, the depth of water in the pan measured and converted into actual inches of rainfall. This test was repeated using different adjustments of the spray nozzle to give various rates of rainfall.

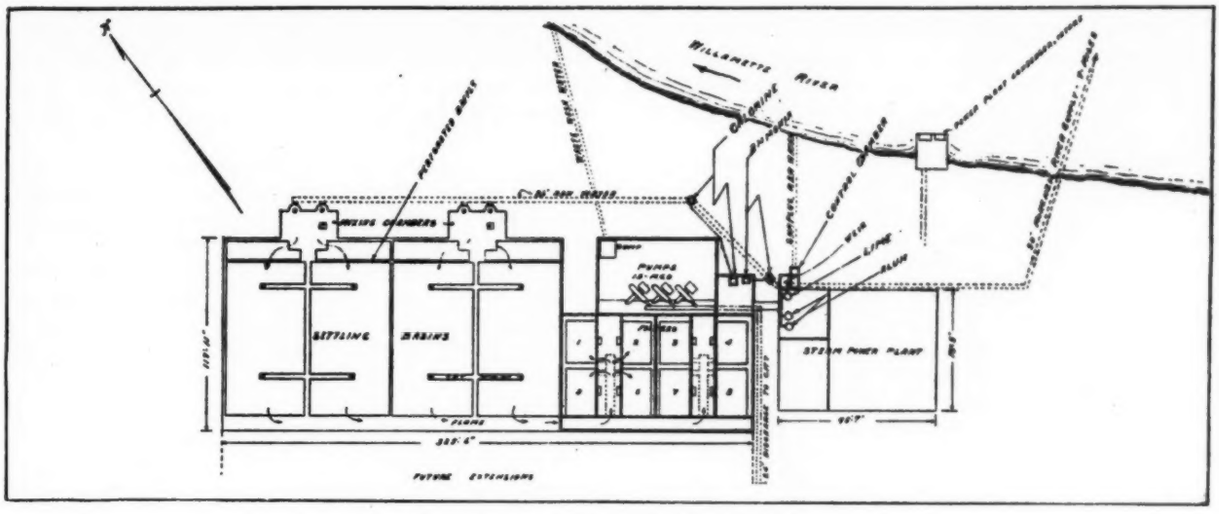
In preparing the specification, the U. S. Weather Bureau was consulted to determine the average annual wind velocity and rainfall for Ohio over a period of years.

The following two paragraphs are excerpts from the Ohio Specifications for Signal Torches:

"Torches shall be capable of burning continuously under normal conditions for a minimum of 25 hours on one filling of kerosene and burn at least 15 minutes in a 35 mile an hour wind or in a rainfall of 2½ inches per hour.

"Torches shall be made of sheet steel not lighter than No. 20 gauge, sufficiently counterweighted at the bottom to right themselves from any position, equipped with a ring or bail handle and coated with a suitable paint or enamel to provide a rust-resisting finish."

All tests made during the study of signal torches were conducted under supervision of R. R. Litehiser, Chief Engineer of Tests, at the Ohio State Highway Testing Laboratory located at Ohio State University, Columbus, Ohio. Tests involving the use of a wind tunnel were made possible through the cooperation of the Mechanical Engineering Department, Ohio State University. Torches will be maintained permanently on sections of Ohio highways which are under repair.



Plan of Eugene, Oregon, Filtration Plant

Operating Eugene, Oregon, Filtration Plant

New plant with capacity for double the present maximum consumption, requiring coagulant only fifteen percent of the time, produces excellent water at a cost of ninety cents per capita per year.

EUGENE, Oregon, built a filtration plant in 1909, soon after buying out the private water system, and was believed to have been the first city in the Pacific northwest to use chlorine in water purification, chloride of lime being used at first. The original filters were built largely of wood, and after 23 years of operation had developed weakness. About half of the sand used in the new plant had been used in the old one, some for 20 years, where repeated washing had increased its uniformity and roundness until each sand particle resembles a tiny pearl.

The supply originally was from the Willamette river, which flows through the city, but in 1926 was brought from the McKenzie, seven miles away, this river having a considerably lower summer temperature, lower turbidity and lower bacteria content. (During 1933 the maximum temperature of the McKenzie water at the plant was 60°, the lowest was 35° and the average was 48°). It also has a calcium carbonate hardness of only 18 parts per million, and a turbidity of from a trace to 400 ppm.

The population served at present is about 20,000. The present maximum daily pumpage is about 6 mgd. and the average winter is 2.4 mgd. The new plant is rated at 12 mgd. The pipe line from the McKenzie to the plant has a capacity of 9 mgd. under the gravity head of 34 ft., which can be increased by pumping when it becomes necessary.

The new plant uses aluminum sulphate, hydrated lime, chlorine and ammonia. The two first are added to the water in the control chamber. The water then flows 250 ft. to the mixing chambers, receiving the chlorine and ammonia on the way. From the mixing chamber it enters the settling basins of 2 mg. capacity through a wall perforated with 4 in. holes spaced 24 in. centers, which effectively spreads it across the ends of the settling basins. The effluent flows through a flume to the filters, and the filtered water into a clear well; from which it is pumped into the city mains and reservoirs.

Owing partly to the large capacity of the plant compared to the consumption, sedimentation begins in the mixing chambers, and the settling time is 12 to 16 hours, and the turbidity is reduced to less than 10 ppm. Of 8 filters provided for, 6 have been equipped, of which 4 are in use at a time, the other 2 standing idle until the next washing; and even so, the rate-of-flow controllers are set at their minimum. Each filter is rated at 1.5 mgd. or 125 mgd. per acre, but will pass 2 mgd. of clear water.

Alum and lime are fed by dry-feed machines, to a point just below the weir in the control chamber where the turbulence produces a good mixing. Motor-driven agitators have been installed but will not be needed until the consumption increases. It requires 3 minutes for the water to reach the mixing chambers and by the time it has reached the top of these, coagulation is complete and settlement commenced.

Alum was needed only 55 days in 1933, and the maximum dosage was 220 lb. per mg. Turbidity was over 200 ppm. on only three days. Jar tests show that the best flow is obtained when the pH of the mixed water is from 6.4 to 6.6, and just enough lime is added during periods of greatest alum feed to bring the pH up to 6.6. Lime was used for only 19 days in 1933.

Pre-chlorination is practiced, using a vacuum type solution feed chlorinator, at such a rate that a residual of 0.1 ppm. is maintained at the outlet of the mixing chambers, after a retention of 30 to 40 minutes, this dose varying from 2 to 3 lb. per mg. It is feared that post-chlorination would give an objectionable taste to nearby consumers, the nearest being only 600 ft. from the pumps. Ammonia was used with the chlorine in sterilizing the plant at beginning of operation, and is available should it be desired.

Two filters are washed each day, after 48 hrs. service, and put back into service 24 hours later. It has been found that a regular schedule of washing gives better results than to regulate the length of run by loss of head. Wash water rinsing through the filters at the rate of 24 in. per min. gives a sand expansion of 50%; but as this rate carries a little sand over into the wash troughs (the crest of which is 24. in. above the settled sand) the rate is kept at a little over 40% expansion. Approximately 2½% of the filtered water is used in washing filters.

A submerged light in the clear well indicates the efficiency of filtration in removing suspended matter; and tests in 1933 showed an average daily count of 6 bacteria per cc, and daily B. coli presumptive tests were negative in every instance. There has been a noticeable improvement in the bacteria content since the 72-hour washing routine was inaugurated in August, 1933.

A window was built in the side of one of the filters, through which may be seen the sand and gravel and the sand expansion during washing.

The total amount filtered in 1933 was 994,000,000 gallons. The costs per mg. were: for alum, 26c; lime, 2c; chlorine, 27c; power for wash water, mixer, etc., 54c; water for hydraulic valves, washing settling basins, etc., 53c.; miscellaneous, 23c.; salaries of 4 operators (including pumping), $4.59; supervision, including bacteriologist, $1.11. The total cost for filtration and pumping (including $8.57 for power for pumping) was $17.28.

Daily records are made of the principal plant operations and conditions, including length of time each pump is operated, kwh. consumed in pumping, quantity of water treated and pumped, chemicals consumed, time of filter washing, quantity of water used in washing, condition of raw and of treated water, water temperature and maximum and minimum outside air temperature. By making the operation as much as possible a matter of routine it is expected that a high quality of water will continue to be delivered and at the same time the cost of supervision be lowered. Maintenance of a certain residual in the mixing chambers, regular washing of filters, and the use of curves in determining the amount of coagulants are a step in that direction.

The above is abstracted from a paper before the Pacific Northwest Section of the American Water Works Association by F. Ford Northrop, who is engineer in charge of filtration. The general operation and maintenance of the plant are under the supervision of W. J. Moore; E. H. Hotaling is chief operator, J. W. McArthur is general superintendent-secretary of the water board; Dr. E. D. Furrer supervises the bacteriological examinations. The new filter plant is called the Carl A. McClain plant in honor of the late Mr. McClain who was general superintendent-secretary of the water board for 14 years. Including the value of the land, it cost $205,000. It was designed by Stevens & Koon, consulting engineers, of Portland.

Water Supply Industry Code

A proposed code of fair competition for the Water Supply Industry has been submitted by the Institute of Water Supply Utilities, Inc., claiming to represent 65 per cent of the volume of the industry (on the basis of incorporated communities served by privately owned industry). A hearing on this will be held Aug. 6.

Maximum work hours are 40 per week in cities of more than 500,000 population; 48 in cities of from 200,000 to 500,000 (with a proviso that within 90 days the Code Authority shall report upon the effect of these hours and shall change the limit from 48 to 40 in cases where so doing will cause no hardship); 48 in places of from 200,000 to 10,000, and no limit in towns of less than 10,000. In the latter places, however, employers shall "in good faith endeavor to adjust the working hours of employees so as to increase employment."

Minimum wages are $15.00 per week for operating employees and office and clerical employees in the North and $14.00 in the South; and 35 cents per hour in the North and 30 cents in the South, for employees paid on an hourly basis.

Softening Water to Increase Revenue

The water commissioners of St. Paul, Minn., report that they are experiencing a loss in revenue from commercial accounts which is becoming a serious problem; this loss being due to the fact that it is practicable for reasonably large consumers to obtain their water supply by private wells drilled into the underlying artesian basin, which water has the added attraction of being cool. Although rates to commercial consumers have been made as low as it is advisable to make them, "The rapid advances made in, and the demands for air conditioned hotels, apartments, etc., have given added impetus to the demand for cold water.

"Since any further rate reductions are not advisable or possible it would seem that the only other alternative to meet this situation is to soften the water. Such a move should prove attractive to all industrial users, as well as being economically justifiable from the domestic consumers' standpoint." The water has a hardness of 163 ppm.

Bring Back the Softener

"YOU never miss the water 'till the well runs dry . . ." By the same token Kent housewives never missed the water softener until Waterworks Superintendent Ollie Young closed it down for repairs several days ago.

The bath tub took on a heavier, greasier ring after dad took his Saturday night bath.

Housewives who haven't bought water softeners for washing clothes since Kent installed the softener back in November, 1930, were storming into stores this week with blood in their eyes.

Once pure white sheets wore a disgraceful cloak of iron rust today, mute testimony that something was wrong with the water.

Telephone calls have been pouring into the office of Superintendent Young, eagerly inquiring when the softener will be again operating.

Persons once skeptical about whether or not Kent could justify an investment of $29,000 in a water softening plant seem to have been converted.

Let's hurry and get that softening plant back in action.—Kent, Ohio, *Tribune*.

Effect of Gas Liquors on Sewage Treatment

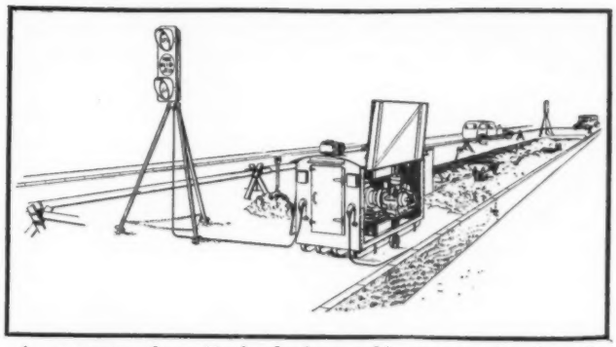
THE presence in sewage of spent liquor from gas works give a great deal of trouble to many sewage plant superintendents in England and methods of solving the problem it presents are popular subjects of discussion at their meetings. At a meeting in March of the Institute of Sewage Purification, Walter Scott, of Bury, read a paper on the subject, which was discussed by Dr. W. Watson of Burnley, F. W. Allen of Bolton and others.

Formerly the gas works boiled off the ammonia before discharging the waste, but for two or three years past the problem has been rendered much more difficult by discharge of the untreated ammoniacal liquor. Presence of the gas liquor at Bury has doubled the 4-hour oxygen absorption test, and the percolating beds have lost much of their bacterial growth and assumed the appearance of washed clinkers. Its presence can be observed through all stages of the purification plant by a characteristic brown color. Mr. Scott "considers it impossible to produce a satisfactory effluent from sewage containing 2% of gas liquor, either as spent or ammoniacal liquor, without entailing a very heavy increase in expenditure. Even with less than 0.35% the color effects are very pronounced" and it "has a distinct retarding effect on sewage purification processes, due to the toxic constituents."

At Burnley, 80% of the sewage is treated in a Simplex aeration plant. Here the gas works discharge a month's accumulation of the waste liquor during only six to thirteen days, bringing the strength from 97 ppm to 140 ppm or more. With the regular 14-hour aeration, the 4-hour oxygen absorption of the effluent was 30 ppm (78% purification), which was reduced to 24 (83% purification) by 17 or 18 hours aeration, and to 21 with 20 hours.

Dr. Watson considered a 5-day oxygen absorption test much more informative than the 4-hour. The 5-day tests gave 55 ppm after 14 hours aeration, 32 after 18 hours and 18 after 20 hours. The albuminoid ammonia was reduced only from 3.8 ppm to 3.3 by the six hours additional aeration.

Sewer built of 36-inch cast iron pipe



A suggestion from England. A portable stop-go signal outfit for regulating alternating traffic around a repairing job. Note the excavating equipment—one pick, shovel and wheelbarrow

At Bury the gas works (municipal) made an annual payment towards the increased cost of treatment of the sewage due to the gas liquor, which was believed to be cheaper than to treat the liquor itself at the gas works. However, D. Ledson stated that a plant in the Ruhr district was extracting phenols from gas liquor by means of benzol, removing 95% of the phenols, which were sold for just about the cost of treatment.

Mr. Scott stated that in Germany "It has been found that on filtering gas liquor through carbon, the phenols are retained in the carbon by adsorption. Carbon filters, or adsorbers, 16 ft. thick are used. After a time they cease to adsorb phenols, and have to be regenerated by having hot benzol passed over them to dissolve out the phenols. The benzol containing the phenols is removed from the adsorbers by steaming, when the carbon is thus regenerated and made ready for use again.

"The benzol-steam mixture is run into a separator to remove the water. The benzol is distilled, leaving the phenols in the form of an oil which is run into a storage tank. The benzol recovered is used for further extractions.

"This process has been tried out at Bruchstrasse (Germany), where all the ammoniacal liquor produced in carbonizing 1,200 to 1,500 tons of coal per day has been treated. During a run of several months 11,000,000 gallons of ammoniacal liquor was dealt with on 4 tons of carbon, needing only 1-3 tons of carbon for replacement. The amount of phenol removed from the ammoniacal liquor was 93.5-96.0 per cent.

"No figures have been published of the cost of working the process, but if crude ammoniacal liquor can be dealt with economically by such a process, so as to reduce the impurities by 95 or 96 per cent, the situation confronting sewage works managers is considerably relieved."

Cast Iron Outfall Sewer

Bowling Green, Ky., in the latter part of 1931 began the construction of a sewerage system and treatment plant designed by the J. N. Chester Engineers, two interesting features of which are the use of cast iron pipe and of R. F. C. funds.

The city was divided into four sanitary districts, each served by a collecting sewer. The first collector to be built was of 10", 12" and 16" de Lavaud cast-iron pipe laid in rock in the bed of a small stream which drained that district. Following this, little was done

until January, 1933, when a request for R.F.C. funds was approved, a loan of $630,000 obtained, and five contracts let, which were completed in April, 1934.

In this new work, cast iron pipe was used for all stream crossings, sewers in the beds of streams, railroad crossings, and 1,350 ft. of outfall to the disposal plant, which is above ground. The outfall is of 36" "Hi-tensile" cast iron pipe supported on masonry piers spaced 12 ft. apart, jointed with hydrotite. The plans called for either a monolithic poured reinforced concrete conduit on piers spaced 15 ft. apart, or cast-iron pipe, and the bids for the latter were much the lower. The contract for this and for the disposal plant was let to Thomas J. Murphy & Bro. of Bowling Green.

The R. F. C. loan will be paid by means of rental charges against the property owners, based on the number of rooms per house and the water consumption.

Pre-aeration of Sprinkling Filter Sewage at Decatur

When Decatur, Ill., put its Imhoff tank and sprinkling filter sewage treatment plant into operation in 1924, its capacity was greatly exceeded due to the amount and organic strength of the starch waste from the Staley Manufacturing Co. To remedy this, a pre-aeration plant was built in 1927, and at the same time the Staley Co. was taking measures to reduce the strength of its starch waste, and by May, 1928, the disposal plant was able for the first time to treat all the city sewage and wastes except at times of high water in the river. At present the usual waste from the Staley Co. is 80 per cent as great as the balance of the dry-weather flow. From 1928 to 1933 there was a reduction in population equivalent from 174,333 to 90,400, while the reduction in sewage flow was from 10.35 to 9.20 mgd; indicating a reduction in strength of sewage (B.O.D. basis) of over 40%. (The population of Decatur was 57,510 by the 1930 census.)

There is one advantage of the starch waste—it reaches the sewer hot and thus tends to keep the sewage warm in winter, aiding digestion in the Imhoff tank and in the digestion tank added about two years ago. The minimum winter temperature in the digestion compartment seldom falls below 65° (except when the starch works are closed down for a few days), and the summer temperatures are between 80° and 100° F. In 1933 the average amount of gas produced per 24 hours was 54,500 cu. ft., from a sewage flow of 9.2 mgd, or 4.9 cu. ft. per pound of suspended solids.

The pre-aeration plant has been in operation since Dec. 31, 1927. Until June, 1928, the waste recovery at the starch works had not become effective, and the plant could not treat all the sewage, and during 1929 and 1930 the flow during certain storms exceeded the hydraulic capacity of the plant, but in 1931 all sewage was handled by the plant. In 1932 and 1933 it was possible to discontinue pre-aeration for 5 or 6 days at a time during several shut-downs at the Staley plant, when the sprinkling filters could purify the sewage satisfactorily without pre-aeration; which saved power costing about $40 a day. Such discontinuance was possible during the spring floods of 1933 also because of the reduced B.O.D. due to ground water dilution of the sewage.

The pre-aeration plant is operated with about 0.33 cu. ft. of air per gallon of sewage, and from 2 to 2.5 hours' aeration, reducing the influent B.O.D. by 17 to 35 per cent, with a power consumption of 250 to 350 kwh per mgd. Suspended solids, however, are usually slightly higher in the effluent than in the influent because of the "bulky" nature of the pre-aeration sludge, but considerable sludge settles out in the clarifiers, and while the aeration liquor contains between 150 and 300 ppm of suspended solids, the settled effluent contains only about 80 ppm.

Treating pre-aerated effluent in 1933, the sprinkling filters, 3 acres area and 6 ft. deep, received an average of 3.07 mgd per acre, and reduced the B.O.D. from 122 ppm to 24 ppm, the effluent having a stability of 95 per cent. During the drought of 1930, for months at a time the volume of flow in the river above the sewage plant outlet was only a third as great as that of the plant effluent, but the river below was clear, odorless and sparkling, and no abnormal growths of water weeds were noticeable in the river bottom or along the banks. In 1929 the State Natural History Survey made a fish count and found many more varieties and about seven times as many fish a hundred yards below the point of discharge from the sewage plant as anywhere else in the river.

The above is condensed from part of a paper by W. D. Hatfield, superintendent of the Decatur plant, published in "Sewage Works Journal" by the Federation of Sewage Works Associations.

Diesel and Electric Pumping Costs Compared

An interesting comparison between electric motors and Diesel engines for furnishing power in municipal water works is contained in a report recently issued on pumping costs in Las Animas, Colorado.

The city takes its water from two wells, operating an electric pump at the Cottonwood and Sixth Street station and a "Caterpillar" D 6100 Diesel Power Unit at the Cottonwood and Fourth Street well. Both wells are of equal depth, but the electric pump has the advantage because it delivers water directly into the standpipe, whereas the Diesel engine pumps into the same reservoir through two blocks of 6-inch main.

A 30-day test was run on the two units and a careful record was kept of performance and operating costs. The results of this test are as follows:

Cottonwood and Sixth St. Pump

Power: Electric motor
Water pumped in 30-day period: 6,217,500 gals.
Electricity consumed: 5120 KW.
Cost per KW: 2.5c
Total cost of electricity: $129.00
Cost of electric power per 1000 gals.: 2.07c

Cottonwood and Fourth St. Pump

Power: Diesel engine
Water pumped in 30-day period: 9,788,300 gals.
Fuel consumed: 720 gals. fuel oil
Lubricating oil consumed: 24 gals.*
Total cost of fuel and lubricating oil: $73.60
Cost of Diesel power per 1000 gals.: 0.75c

*Lubricating oil was changed every 60 hours during the test, though this has since been increased to 70 hours.

Equipment and Methods for Thawing Frozen Mains and Services

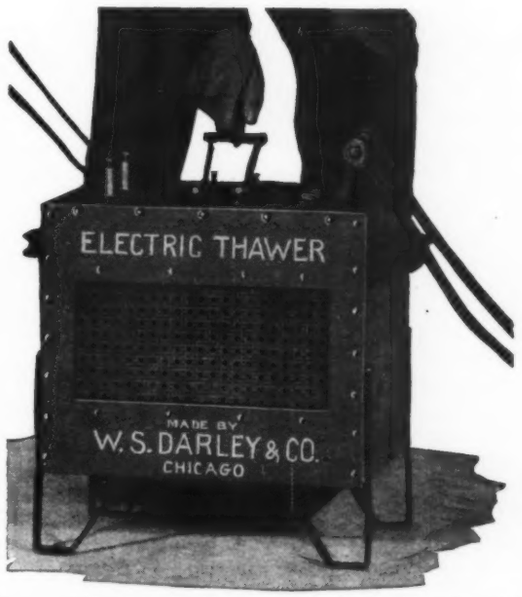
INFORMATION concerning the extent of freezing of mains and services in the communities of New York State last winter was collected, by means of questionnaires and correspondence, by C. A. Holmquist, director, and A. F. Dappert, principal sanitary engineer, Division of Sanitation, State Department of Health, who have kindly furnished us with a synopsis of the same.

Replies were received from 306 municipalities, of which 147 reported frozen mains, 117 broken mains, 93 frozen hydrants, 63 broken hydrants, 251 frozen service pipes and 184 broken service pipes. Buffalo alone reported 50 broken mains.

Depth of pipes had some effect in preventing freezing, but not so much as might be expected. The cities whose mains and services were laid with 4 to 6 feet cover (of which there were 261) had less trouble than those with less than 4 feet (of which there were 39), but also less than those with more than 6 feet (of which there were 6). One city had more than 7 feet cover but experienced trouble with freezing. Possibly the explanation is that 4 feet is the minimum cover that should be had anywhere in the state, while more than 6 feet is practiced only in the unusually cold sections, where the thermometer fell to more than 30° below zero and frost penetrated more than 6 feet.

For thawing, the electrical method was that most commonly employed and generally most satisfactory, especially for services. Several used salt, blow torches and steam on frozen hydrants, and wood, coke or charcoal fires for mains. The electrical method was used exclusively in 67% of the municipalities reporting, and in combination with other methods in 23%.

The majority using electricity relied upon the service furnished by local power companies but a number purchased their own equipment. Of the former, all reported satisfactory results (except for the charges made by the power company); but some cities which had purchased commercial equipment found difficulties in thawing mains, especially those laid with leadite or hydrotite joints, and copper service pipes. The reason for the latter probably was insufficient capacity of the apparatus, for several municipalities with medium and large-capacity outfits reported no difficulties in thawing pipes with such joints. In Mechanicville such joints are bonded and no difficulty was encountered. Because of the high conductivity of copper, it requires a longer time or greater current to thaw copper services than steel or iron ones.

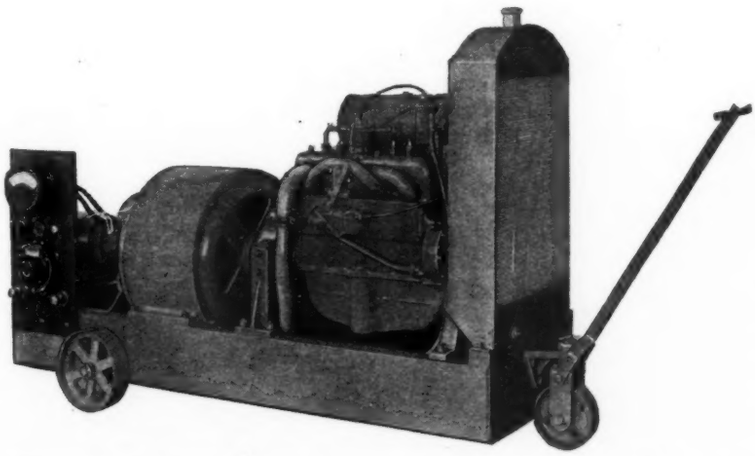


A transformer-converter, air-cooled. 400 amp. 220 volts A. C. to 20 volts, using current from electric cables. Weight, less than 100 lbs.

The development of tastes following electric thawing of both copper pipes and those using joint compounds (which contain sulphur) was rather generally reported, but these are quickly removed by flushing. Several instances were reported where rusty water with a musty taste developed after thawing, which was attributed to the removal of tubercles from the mains.

In one instance it was reported that electric thawing burned out all hydrant packings. In another instance the superintendent attributed leaky hydrants following electrical thawing to the use of the hydrant as a terminal. In a good many cases leaks or breaks are reported to have occurred during or immediately following the thawing process.

Some municipalities reported that lead joints were affected and in some cases melted. One municipality reported that



Engesser pipe-thawing set—gasoline engine, generator, storage battery, etc. 250 to 500 amp. A. C. current. Size, 6' x 2½'. Weight, 1800 lbs.

in every instance following electrical thawing of service pipes a break developed about the middle of the pipe. One municipality reported that generally breaks occurred in the goosenecks between the mains and services. Another reported that in 9 out of 10 instances where services were thawed electrically, breaks occurred in the lead goosenecks, leaving holes about the size of a silver dollar.

In one municipality the practice of attaching a piece of copper tubing to the corporation stop on the main and carrying it to the surface as a future electrical connection was followed in all cases where it was necessary to dig during the past winter to make such connections. This practice was recommended by another municipality as a future policy in case of all new services and replacements.

The cost of the equipment purchased varied from $35 for a steam apparatus to $1,225 for a high-capacity electrical thawing outfit. Several municipalities used moderate-capacity electrical outfits costing about $500, but the majority paid from $150 to $250.

The following list of firms were reported to have furnished thawing equipment to New York State municipalities this year:

W. S. Darley Co., 2810 Washington Blvd., Chicago, Ill.; The Engesser Mfg. Co., Watertown, N. Y.; The Chautauqua Electric Motor and Repair Co., Jamestown, N. Y.; General Electric Company, Schenectady, N. Y.; The Westinghouse Electric Co., Pittsburgh, Pa.; Ezra R. Fern Sons, 1130 Mulberry Street, Scranton, Pa.; The Lincoln Electric Co., 357 Bruce Street, Syracuse, N. Y.

In 48 per cent of the municipalities reporting, the property owners paid for the cost of thawing water service pipes; in 27 per cent the cost was borne jointly by the municipality and property owner; and in 25 per cent the municipalities thawed services without charge to the property owner.

Where equipment was rented, the charges varied from $2.50 to $15 per hour. Where a set price per service was established, $5.00 was a frequent charge, although in many instances charges of $10.00 or more were made.

The costs for thawing services averaged $8.50 but varied from $2.00 to $50.00.

Generally the cost of thawing by steam, hot water or wood fires was reported to be greater than by electricity, particularly on house services.

A study of the reports received led Messrs. Holmquist and Dappert to draw the following conclusions relative to electric thawing:

"In many municipalities where excellent results were obtained in the electrical thawing of service pipes, steam or wood fires were used for the thawing of frozen mains. This would suggest that in many instances the electric thawing outfits were of too small capacity to work effectively on larger size pipe.

"The logical conclusion that may be inferred from the various experiences recorded is that electrical thawing outfits will operate with degrees of success about in proportion to their capacities. The very small-capacity outfits will apparently work satisfactorily on small lengths of iron service piping but are generally unsatisfactory for use on copper services. Medium-capacity outfits will operate successfully on larger lengths of pipe, including short lengths of small size mains and generally on copper services. High-capacity units generally will work satisfactorily on mains of considerable lengths, on copper services and on pipes jointed with leadite.

"Because less difficulties were reported from municipalities which procured thawing services from local power companies, it is considered that best results will be obtained when electrical thawing is under the supervision of a competent electrician. The work requires at least supervision by someone who is familiar with the making of electrical connections and who understands thoroughly the principles involved and who can arrange hook-ups that will avoid current losses. Notwithstanding this, however, very good results were obtained in many instances by inexperienced men who were intelligent enough to follow the equipment manufacturer's directions.

"In selecting electrical thawing equipment, consideration should be given to the size and lengths of piping and the pipe materials that will probably have to be thawed. If electrical thawing of services only is contemplated, then a lower capacity outfit will be needed than if thawing of mains is contemplated. Furthermore, it is believed to be generally advisable to provide an outfit with variable output so that power requirements can be adjusted for the particular conditions. With outfits which have fixed outputs, the job has to be fitted to the machine rather than the machine to the job."

Omaha Installs Traffic Markers With CWA

Omaha, Neb., as a work relief project, is installing permanent traffic markers at important street intersections and at street car stops. This is an example of a minor public works job which cities can initiate under the work division of the Federal Emergency Relief Administration.

The traffic markers are being installed at street car loading stations and at street intersections for pedestrian lanes. Concrete blocks capped with white cement are placed in old pavement surfaces, flush with the top. The lines stand out in sharp contrast—do not require maintenance. This work, which was started as a CWA project, calls for installation of 240,000 lineal feet of markers.

The markers, which are made at the city sewer yard, are 24 by 6 by 4 inches, capped with ¾ inch of white cement mortar. They are set in trenches dug in the pavement surface, and embedded in early strength concrete, so that areas being improved are only out of service 24 hours after the installation is made.

A large amount of labor, mostly unskilled, is requird, both for manufacture and installation.

Precast concrete traffic markers in Omaha

The Editor's Page

Artificial Supplementing of Underground Water Supply

Following several years of low rainfall, the north-central states west to the Dakotas are suffering from a lack of water not only in the surface streams but underground as well, and the latter is really the more serious, for it will take longer to restore and does more serious damage to forests and other vegetation.

How serious this has become in North Dakota was told briefly in the "Water Wheel" for May; but in a less degree the underground depletion extends eastward across Ohio. Part of this depletion in the latter state is attributed to human agencies. Says the "Ohio Health News": "One plant alone, in the Miami Valley, has lowered the water table in its vicinity by 26 feet, and another, in an eastern county, which draws millions of gallons daily from one of the largest gravel deposits in Ohio, runs it all, after using, into a creek instead of returning it to the finest filter bed in the world."

The suggestion is made that water derived from underground should be returned underground and not into streams, since in the former case it would depart but slowly from the vicinity and would become safe for use again in a few hundred feet, besides supplying moisture for vegetation by raising the water table; while that discharged into streams leaves quickly for the ocean and is likely to be polluted more than it is purified on the way. In our July issue we told how a few cities are putting water underground, some to purify it, others to store it for use during the dry season. Applying the idea to a whole state or other large area is a proposition which may not be so crazy as might at first appear.

Relief From Unemployment—Now; and From Excessive Maintenance Costs—From Now On

"When the first allotments of funds for the relief of unemployment were made, there were some projects proposed and accepted that were almost purely of the "made work" variety, and a good many others that involved improvements of a more or less temporary nature. The situation which resulted in the carrying out of such projects, was quite understandable. Unemployment was acute, and the panic of fear made the nature of any improvement seem relatively, or even entirely, unimportant, just so long as it put men to work.

"With returning confidence should come a new carefulness in selecting and constructing public work projects. The very fact that these projects are required to afford employment to large numbers of people increases the importance of selecting worthwhile projects; and it magnifies the need that these be comprehensively planned and competently executed. The basic idea now should be that the first cost will represent an investment of continuing value, and not be just a down payment that will entail a long succession of ever-increasing maintenance charges."

"The unemployment relief work sponsored and paid for by the Federal Government and the states has been carried out in a commendably prompt and vigorous manner, all things considered. But it has been the general policy to relegate to the background the engineers, who ought to be the foundation on which the whole structure should be reared.

"I believe that the most costly relief work that can be given is relief to engineers. A staff built up solely on the basis of need will cost money today, but it will cost still more five, ten or twenty years from today. Adequate engineering services, both in quality and in quantity are a necessity for the carrying on of any work, whether or not it be relief work; and engineers should be employed and paid for on the basis of the work to be done.

"There are plenty of needy engineers, and many of them have plenty of ability. But except in the lowest grades they should be employed on the basis of their ability, and not of their need. And they should be paid accordingly."

This is a composite editorial. The first two paragraphs were written by Quincy Campbell; the others by a man familiar with the utilization of engineers in relief work. The Editor has taken the liberty of joining them together because, after all, they aim at about the same end.

The Water Fund Is Liquid

A subscriber in sending in a subscription covering the next two years says: "This will be paid by a warrant drawn on the water fund (always liquid)."

Perhaps a jest; but like many another word spoken in jest, full of truth. There have been few cases of municipally owned water plants which have not had liquid funds, even during the past few years. In many instances, the funds of the water department have been available to help the needy city, low in ready cash because of delinquent taxes.

The same has been true of municipally owned light and power plants, which are often under the same management. In a number of cases the profits from these plants have been sufficient to pay all operating expenses of the city, leaving the city tax free. Efficient operation of these utilities appear to be the rule, rather than the exception, despite all we hear about the advantages of private ownership.

It is a fortunate community, which has a couple of utilities—such as water, and power and light—which bring in a profit, even during years of depression, and which are "always liquid."

Good Work by the PWA

Many complaints have been heard about the lack of celerity, exhibited in the early days of the PWA, in getting jobs to the dirt-moving stage. These may have more than an element of truth, though it is our own belief that in this regard the PWA has been more sinned against than sinning. But no one can complain about the speed with which the allotments for the most recent batch of jobs have been made. Congratulations, PWA.

Mixing oil and gravel in place

Powdered Asphalt Oil Mats

By H. C. Offutt

OIL mat construction practice in Indiana, up to 1930, consisted of adding new aggregate to the loose material on the road surface, applying a viscous oil and mixing. This was quite satisfactory in furnishing a smooth-riding surface which was appreciated by the traveling public; and the cost of maintenance, as compared to drag maintenance, was about 80% lower. The oil mat stopped the loss of aggregate through abrasion and suction, but a serious disadvantage to the road users was the fact that the oil did not set up for two or three weeks.

The first use of powdered asphalt in Indiana was on an experimental project in the fall of 1930, near Howesville. The powdered asphalt was spread over the surface of freshly mixed oil and aggregate, with the result that the fresh oil in the mixture was set by the fourth day, thus eliminating one of the most serious objections to this type of oil mat construction.

On later projects, most of the powdered asphalt was mixed uniformly throughout the mixture of oil and aggregate, using a slight excess of road oil. Part of this excess of oil was absorbed by the remainder of the powdered asphalt which was spread on the surface, and the balance by a light application of clean, dry chips, spread after most of the compaction had taken place. During 1931 and 1932, about 700 miles of such construction was laid in Indiana.

Observation of the oil mats containing this material has indicated that they are very lasting and durable. Deterioration and crumbling have not become noticeable after three years of use. The elasticity and resiliency of the wearing course were evident, and retreatments apparently will be necessary only about every three or four years. An examination of the mats showed that, in this type of construction, a thicker film was formed on the particles of the aggregate, which it is believed will result in a more durable mat.

Eradicating Weeds Along Highways

Many kinds of weeds grow along highways. To keep the highways neat, and to prevent weed seeds from spreading into nearby cultivated land, these weeds should be cut or destroyed before the seeds have ripened. Weeds may be cut or destroyed by chemicals. Methods described below are based on an article in *The Canadian Engineer*, by Arthur H. Martin.

When cutting weeds, the men should be in gangs properly equipped for the work. A small truck, equipped with a grindstone, scythes, brush hooks, axes and other necessary equipment is desirable and handy.

Chemicals properly applied with a power sprayer prove very effective on most weeds and at the same time do not kill grass. Professor J. E. Howitt of the Ontario Agricultural College, who conducted some 400 experiments with chemical weed killers in 1931, says that ox-eye daisy and wild carrot were killed with one application, applied just as they were coming into flower, of Atlacide or Weed Cop at the rate of 1 lb. per gallon of water per 100 sq. ft., and by 1 lb. sodium chlorate per gallon of water per 400 sq. ft.

Blue weed and burdock were killed with one application of sodium chlorate at the rate of 8 oz. per gallon per 400 sq. ft., and by one application of Atlacide or Weed Cop at the rate of 1 lb. per gallon of water per 100 sq. ft. Poison ivy and chicory were sometimes killed with one application at the rate of 1 lb. per gallon of water per 100 sq. ft., but frequently new growth appeared, making a second application necessary. At least two applications were necessary to kill sow thistle.

Sodium chlorate was found to be one of the best and cheapest chemical weed killers, but owing to its inflammable nature, it is doubtful if it should ever be recommended for roadsides. Should lighted cigar or cigarette butts be thrown on areas of weeds sprayed with sodium chlorate, disastrous fires are likely to occur.

According to Professor Howitt, sodium chlorate is almost as dangerous as dynamite and should be handled with the same care and caution.

Atlacide and Weed Cop do not carry this fire hazard and may be used with safety.

When township roads are built or repaired, very often large boulders, stumps and other waste material are left at the sides of the road, thus making weed cutting with a mower an utter impossibility. Would it not pay to clear the entire right-of-way, construct ditches with gently sloping sides so that the mower could be used very largely for weed cutting?

Weed and Road Vegetation Control

Maintenance forces of the California Highway Department during the past five years have carried on a regular program of spraying and burning of roadside vegetation to minimize hazard from fire to crops, pastures and forest areas. Treatments totalled 1175 miles in 1932. The areas selected for treatment are generally along grain fields, pasture, forest and heavy brush lands. It is not applied through built-up areas, orchard, country or adjacent railroad right-of-way, which in effect produce a natural fire break.

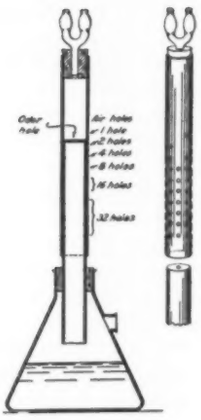
The roadside growths are sprayed with oil and burned over under rigid supervision. The crews engaged on this work use every precaution to protect traffic, trees, shrubs, fence posts and other inflammable property.

Where infestation of noxious weeds occur, such as yellow star and Russian thistle, Johnson grass, Bermuda grass, hoary cress and puncture vine, infested areas are inspected at regular intervals, and spraying with 27+ gravity diesel oil is carried out at regular 10-day intervals, so there will be no opportunity for plants to develop sufficiently to seed.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

NOTE: Reference numbers refer to the Bibliography which follows these abstracts.

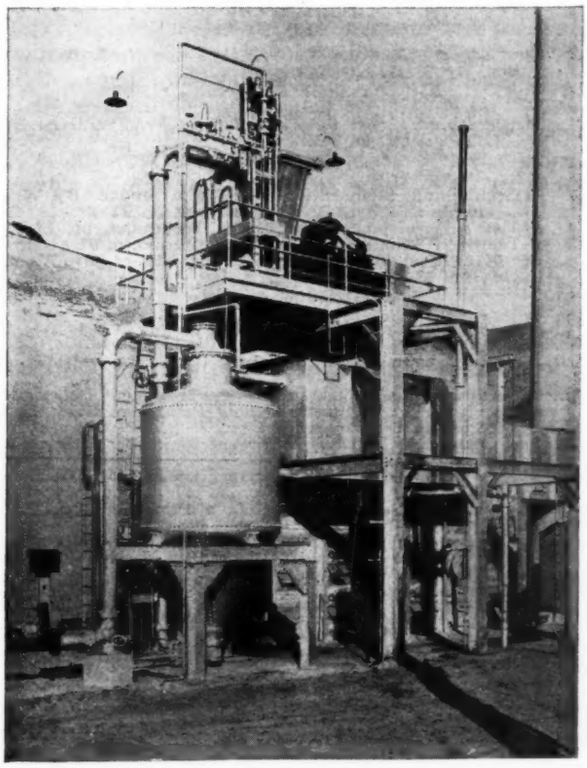


The Osmoscope in its simplest form.

THE population equivalent balance is used by Decatur to represent the strength of crude sewage, the efficiencies of the treatment process and the strength of the final effluent.[C7-7] This gives figures significant to layman as well as engineer, is much more descriptive and equally valuable a measure, and is especially valuable in comparing industrial waste pollution with that of domestic sewage. "This equivalent is based on the determination of the B.O.D. of the samples and of the amount removed by each process. The following equation is used for the calculations: Population equivalent=ppm B.O.D. (5-day) × mgd × $(^{8.33}/_{.17})$."

During 1933 the P.E. of the crude sewage averaged 90,400, of which 22,500 was removed by the Imhoff tanks, 13,000 by the pre-aeration tanks, 42,900 by the sprinkling filters, 1,595 by secondary sedimentation, and 452 by storm treatment tanks; leaving 9,900 in the final effluent.

Odors from sewage are measured by the osmoscope [GG8-5]—an instrument for determining the number of dilutions with pure air needed to make the odor barely perceptible. The strength of the odor is designated by a pO number, which is the exponent of 2 which gives the number of dilutions; a pO of 4 means $(2)^4$, or 16 volumes of fresh air to one of the odorous air. Measuring odors at an activated sludge plant, the authors found pO values as follows: raw sewage, 5; effluent of aerated skimming tank, 4; effluent of primary settling tank, 5; effluent of activated sludge tank, 3; effluent of final settling tank, 3; return activated sludge, 1; screenings, 5. Digesting sewage solids at 59° temperature, 8 after 13 days, 5 after 17 days, and 3 after 21 days. At 104° the pO values were: 8 days, 19; 10 days, 15; 13 days, 12; 14 days, 8; 17 days, 7; 21 days, 9. At 140° the pO values ranged from 17 to 35. As the last means 30,000 million dilutions it is open to suspicion, but at least it indicates that themophilic sludge digestion creates an odor problem of appreciable magnitude. Cowles found[GG8-6] pO values of 2 pungent and 4 soapy for effluent of trickler; 3.5 musty for sand filter effluent, and 1.0 chlorine and 2.0 musty for same after being chlorinated.



Hyperion, Los Angeles, sludge incineration plant. Burns 50 tons of 85% moisture screenings in 24 hours.

Incineration of screenings began by Los Angeles in January, 1934.[L7-1] The screenings from 130 mgd of sewage, through grids with 1 in. clearance and revolving cylindrical screens, etc., with 1/16 in. slots amount to 33 tons a day of rags, packing house wastes, fruit skins and a little fecal matter, with an average moisture conent of 83.5%, 9,934 Btu and 10.3% ash content. The present plant is a Morse-Boulger destructor, capacity 25 tons of dewatered screenings (50 tons of wet screenings) per 24 hrs., a roll press for dewatering screenings to 70% moisture content, capacity 3 tons per hour, with ejector, 8-ton bin and other accessories. Both dewatered screenings and the water therefrom are weighed and metered automatically. The temperature of the gases as they pass from the upper to the lower hearth is usually 1,600°, and 1,200° at the flue end of the combustion chamber. A high-pressure, external, atomizing type of oil burner is located in the main fire box over the upper hearth, and a similar one at the end of the lower pass to be used when starting up or for exceptionally odorous gases. During a 72 hr. test run, 7.09 gal. of oil per wet ton of screenings was used, and 0.28 kwh of current. The pressed screenings averaged 66.2% moisture. The plant, by this test, exceeded the guarantees as follows: Capacity, 16.1%; oil used, 24.4%; air used, 36.7%; power used, 68.2%. (A considerable part of this should apparently be credited to the roll press, since the pressed screenings contained 66.2% moisture instead of the guaranteed 70%.) The contract price of the plant was $32,500.

Sewage bacteria in air are being studied by Fair and Wells[GG8-5] by use of an air centrifuge. For years it was considered that bacteria almost never passed from sewage to air, but "trickling filters, activated sludge, preaeration tanks and aerated skimming tanks afford

a relatively large measure of opportunity for contamination of air through the medium of evaporating droplets. . . . Laboratory tests in which air was blown through a 5-inch diffuser plate into an inverted 5-gallon carboy without a bottom showed that the rising air bubbles liberated at the surface about 5,000 droplets of water per cubic foot of air"; each droplet evaporating almost immediately and containing one or more bacteria. With 1/3 cu. ft. of air per minute being blown through the carboy with B. coli in the water, placed in the center of a room of 50,000 cu. ft. capacity, 31 to 55 B. coli were recovered from 10 cu. ft. of air in all parts of the hall, some 35 ft. from the carboy; the relative humidity of the air being 31%, favoring evaporation of the droplets. "In the light of laboratory tests such as these, we must expect to find bacteria in the air above sewage treatment works in which sewage is broken into a fine spray"; in fact, B. coli were recovered from air above activated sludge units and near trickling filters.

"Partial chlorination of sewage has shown[GG8-8] that the numbers of B. coli and total bacteria are reduced long before the chlorine demand of the sewage is satisfied. There is no direct relation between chlorine demand satisfaction and percentage reduction. Materials in solution and suspension may cause a lag in kill or even prevent kill. The percentage reduction varies not only with the dosage but also with the time of contact. This is due to the interfering substances present. With 10-minute contact periods not all chlorine demand needed to be satisfied to produce a greater than 99% B. coli and total organism reduction." Dr. Rudolfs also said he doubted whether, as was at first believed, contact periods were sometimes too long; certainly results are improved by periods exceeding 10 minutes. According to the Research Committee:[GG8-13] "Satisfying only 50 percent of the chlorine demand of raw sewage will kill 70 percent of the bacteria in 5 minutes and 92 percent in 10 minutes."

Hydrogen sulphide formation does not occur in fresh sewage in appreciable amounts in less than 2 or 3 days;[C7-1] but if stale solids be added, it begins at a rapid rate in a few hours. Rate of production increases with tempterature up to 30°C. "Sulphates present in sewage in greater amounts than required to satisfy the oxygen demand for stabilizing the organic material do not increase the rate of production of sulphides." Neither dextrose nor sodium carbonate at a concentration of 100 ppm increases the rate of sulphide production. Ferric chloride at a concentration of 10 to 20 ppm stimulates sulphide production initially but reduces the concentration of it after some time.

Control of H_2S odors may be by prevention or by removal.[C7-17] "The greatest step forward in the prevention of H_2S formation undoubtedly is chlorination of the sewage, either raw or in the course of treatment. . . . The general opinion seems to be that if the H_2S in the raw sewage can be kept below 1 ppm, no difficulty will be encountered in subsequent treatment or disposal."

Removal may be by aeration, chemical treatment, or other methods. With aeration, the liberated gases must be disposed of, as "by passage through activated carbon filters or through scrubbers using chemical absorbents." For removal by chemical treatment, use is made of iron compounds such as ferrous or ferric sulphate and ferric chloride. Chlorine applied as a hypochlorite is more efficient than when used direct. Among other methods are mentioned the vacuum or "degasification process" (of doubtful value), activated carbon (expensive), and return of sludge from sprinkling filter clarifiers to the raw sewage (Rudolfs).

A 36" **cast iron sewer** 1497' long, after 30 years' service was found to have 80% of its original carrying capacity, the Williams-Hazen C being 96.0.[G7-4] "The portion of the pipe below the minimum flow line was found to be relatively smooth, with little or no corrosion. The portion between the minimum flow line and the level of the average daily maximum flow (a vertical height of 13") was heavily coated with a slimy crust ¾ in. thick. Heavy corrosion with pitting to a depth of ¼ in. was observed under this slime." Above this there was substantial corrosion but no slime. This pipe had been given an "Angus Smith" coating. With the smooth linings now available, the author calculates that the initial capacity would have been 25% greater and the present capacity 55% greater.

Bibliography of Recent Sewerage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

D *The Surveyor*
8 *July 6*
1. Sewage Disposal at Stockport, pp. 3-5.
2. Experimental Work on the Secondary Sludge Problem. By J. H. Edmondson and C. Lumb, pp. 7-9.
3. The Solution of Oxygen from Air Bubbles. By W. D. Scouller, pp. 15-16.

E *Engineering News-Record*
8 *July 12*
1. Sewage Plant Performance at Grand Rapids, Mich., p. 50.

H *Municipal Sanitation*
8 *July*
1. Disintegration of a Concrete Sewer. By Geo. W. Marx, pp. 224-226.
2. Handling Oils and Greases at Sewage Treatment Works, p. 226.
3. Sanitation Today. By Leon B. Reynolds, pp. 227-229, 245.
4. Validity of Sewer Assessments. By Leo T. Parker, pp. 239-240.

J *American City*
8 *July*
1. New Edgerton Sewage Works Help Clean Up Rock River Valley. By W. G. Kirchoffer, pp. 61-62.

M *Canadian Engineer*
8 *July 3*
1. Armco Paved Invert Pipe Installed at Fort William. By Col. L. E. Jones, pp. 3-5.

P *Public Works*
8 *July*
1. *t.* Drying and Incineration of Sewage Sludge. By Willem Rudolfs and Wm. H. Baumgartner, pp. 13, 30.
2. A Year's Developments in Sewage Treatment, pp. 18-19.
3. *n.* Distillery Wastes and Stream Pollution, p. 31.
4. Revolving Distributors for Trickling Filters. By W. A. Darby, pp. 37-38.

S *Construction Methods*
8 *June*
1. *c.* Belt Conveyors Distribute Concrete for Wards Island Sewage Plant, pp. 26-30.

GG *Proceedings, New Jersey Sewage Works Association*
8 *1934*
1. Operation of the Princeton Sewage Treatment Plant and Sanitary Survey of Streams about Princeton. By I. Russell Riker, pp. 1-5.
2. The Little Falls Sewage Treatment Plant. By Edward F. Lawler, pp. 6-12.
3. A New Method of Sludge Drying. By John R. Downes, pp. 13-15.
4. The Value of Sewage Sludge as a Fertilizer. By C. G. Wigley, pp. 16-19.
5. Measurement of Atmospheric Pollution and Contamination by Sewage Treatment Works. By Gordon M. Fair and William F. Wells, pp. 20-27.
6. Some Observations on Instruments to Measure Odor Intensities. By M. W. Cowles, pp. 28-34.
7. *t.* Ferric Chloride in Odor Control. By A. E. Griffin, pp. 35-36.
8. *t.* Effect of Partial Chlorination and Contact Time on B. Coli Reduction in Sewage. By Willem Rudolfs, pp. 37-42.
9. Activated Sludge—Some Notes and Comments. By Sherwood Vermilye, pp. 44-49.
10. *t.* Some Biochemical Indices of the Condition of Activated Sludge. By H. Heukelekian, pp. 50-55.
11. Use of "Electric Eye" at Sewage Treatment Plants. By Floyd A. Hoffman, pp. 56-57.
12. Some Results from Experimental Mechanical Aerators. By I. O. Lacy, pp. 58-61.
13. Report of Research Committee, pp. 62-63.

Specifications for Portland's Refuse Incinerator

THERE has been constructed for the city of Portland, Ore., an incinerator for burning the city's garbage mixed with a small amount of combustible rubbish, the contract for which was based upon specifications aimed to offer competition among all suitable types and designs, with equitable comparison of costs, and to secure for the city a plant which, at the least total annual cost, would destroy in one day 150 tons of refuse (80% garbage and 20% rubbish, by weight) without any nuisance.

The contract was awarded last January to the D-N Corporation, on its bid of $131,422 for the complete plant, including furnaces, buildings, chimney, tools and appurtenances. One hundred and eighty calendar days was allowed for completion, following which the plant was to be operated for a 60-day test, and immediately thereafter be paid for in full, or rejected if not meeting specified conditions.

Each bidder was required to name five or more plants of his design or construction, at least one with a capacity of 150 tons in 16 hours, which had been in operation at least two years.

General Provisions

In comparing the bids, consideration was given to the following: Completeness of plans and specifications; Total bid for construction; Annual cost of operation; Total annual cost; Ease of operation; Ease of repair; Combustion and heating efficiency; Ease of cleaning combustion chambers and flues; Durability of structures; Appearance; Record of operations elsewhere; Financial standing of bidders. Decision concerning most of these must be largely a matter of personal opinion, but definite mathematical comparison can be made of the total bid, annual cost of operation, and total annual cost; also to some extent of the combustion and heating efficiency.

Under the last head would be included, we suppose, the specification requirements that the plants be able to destroy 150 tons of refuse, 80% garbage, in sixteen hours, which refuse may include wood, paper, stable refuse, canned fruit, dead animals, street sweepings, fish offal, trimmings of lawns and leaves, incinerating all refuse "to a clean, odorless mineral ash or clinker containing not over one percent of organic material"; that "during normal operation the temperature in the combustion chamber shall average at least 1500°F. and shall at no time fall below 1300°F."; that "during the process of incineration practically no dust, smoke or gases will escape from the furnaces into the building from any openings while charging, stoking, firing or operating under forced draft"; and that "when the plant is operated at its rated capacity, it shall create or cause no nuisance by the escape of obnoxious odors, gases, dusts or dark-colored smoke from either the buildings or the chimney."

In calculating the total annual cost, the lump sum bid for construction and the bidder's guaranteed cost of operation were considered, the latter on a basis of 300 days operation per year at rated capacity, with an assumed life of eight years and interest at 6%. This "cost of operation shall be understood to be the cost of superintendence, labor, power, water at regular city rates, fuel, lubricants, supplies, repairs and all other operation and maintenance costs as shown by the regular and orderly operation of the plant when running at rated capacity, and not as shown by any special, short-time test run. It is understood that the operating test which shall be used as a basis for acceptance of the plant shall cover a period of 60 days."

The cost of operation is to be "made up approximately as follows:"

½ of service of Supt. .....rate $6.00 per 8 hr. day
½ of service of Clerk .....rate $3.00 per 8 hr. day
Service of Foreman .....rate $6.63 per 8 hr. day
Service of Foreman .....rate $5.40 per 8 hr. day
Service of Fireman .....rate $5.25 per 8 hr. day
Service of Laborer .....rate $4.75 per 8 hr. day
Power—K.W.H. per ton, computed at an average rate of $0.02 per K.W.H.
Water—Cubic feet per ton, computed at the rate of $0.07½ per 100 cubic feet.
Commercial Fuel: Slabwood at $4.20 per cord. Sawdust at $3.96 per unit. Fuel oil at $0.05 per gallon.
Lubricants and supplies, as follows:
Maintenance and repairs, as follows:
Other costs, as follows:

All of these estimated and determined in amounts per ton incinerated. Should the cost of operation exceed the guarantee, the excess cost per year (300 days of operation) shall be capitalized on the basis of 8 years life and 6% interest, and this amount to be deducted from the price bid.

Should the plant fail to meet the specifications and guarantee when tested, the contractor may demand a second test, in which case "the city shall take over and operate the plant, without payment therefor, until a second and final test shall have been made, which test shall be made at such time as the city may select, but shall be completed within six months of the completion of the first test."

The contractor was required to give a bond, in the full amount of the contract, remaining in force for five years on the building and chimney and one year on the interior construction and equipment, during which periods he will replace immediately any parts failing because of faulty material or workmanship.

Technical Requirements

The aim was to make it possible for any suitable incinerator to be proffered in the bidding, but to specify very definitely what services it should perform and what conditions it should comply with. The specifications were very complete, filling 46 typewritten pages. Requirements of special interest, as given in the specifications, are quoted or abstracted below.

The plant is to be able to receive 150 tons in 8 hours and burn it in 16 hours, with facilities for storage to permit this.

The building and floors are to be of concrete, the latter finished with a floor hardener. There are to be a locker room, lavatories, showers, and an office; an oil-burning hot-water heating plant, and hot water for showers; drinking fountains; 1½" fire hose on reel on each floor, with necessary piping; floor drains on each floor, with clean-out plugs, connected to sewer; a 20-ton motor truck scale inside the door at the entrance driveway, with beams on dials in an adjacent weigher's office; and electric light of 6-8 foot-candles and electric power for the power-consuming devices; a chute to carry from the charging floor any ashes or non-combustibles brought in.

Furnace. The furnace is to be constructed of several units, each of which can be operated independently. Provision is required for dumping large animals directly into the furnace from the vehicle without need of mutilation.

The dimensions of the burning chamber shall be such as to provide for a proper fuel bed on the grates and full and free passageway for the hot gases flowing to the combustion chamber. The area of the gas passageway shall be sufficient for the free flow of the volume of gas generated at at least 1500° F.

The temperature in operating the incinerator should not be materially affected by opening charging doors, stoking, dumping grates or cleaning ash pits and should at all times be sufficient to destroy any and all obnoxious gases or materials. The design of the incinerator should be such as to avoid the danger of garbage or refuse packing in some portion of the burning chamber, thereby tending to reduce the necessary temperature for complete combustion and causing smoke and odors. All garbage and refuse should be easily accessible to the heat developed in the furnace. It is the desire to obtain an incinerating plant that will destroy the garbage and refuse with the least possible assistance of commercial fuel.

Doors—The doors covering the stoking openings shall be of the guillotine type, and the doors covering the ash pit openings shall be of rugged construction. These shall be so designed as to prevent sagging and anchorages for this purpose shall not extend into or through the fire brick lining.

Openings through the brick work for stoking and ash removal shall be of sufficient dimensions to permit the use of necessary tools for the purpose with freedom and ease and these openings shall be so designed that there shall be practically no damage caused to the jambs and arches by such tools. The stoking openings shall be provided with cast iron liners to protect the brick work. Arrangements shall be made for the performance of the major stoking operations without the necessity of opening the large stoking doors and with the minimum allowance for cool air inrush. All doors will be arranged to close air tight, and provision shall be made to prevent the discharge of hot gases to the outside when the doors are opened for any purpose.

Grates.—The grate or grates of the furnace shall be so designed as to afford a free passage for the air to support combustion with the least practical frictional resistance. Perforated or herring-bone grates will not be approved or accepted. The total air passageway shall be not less than 40% of the grate area. Arrangement shall be provided for removal and replacement of portions of the grate or grates without necessity for complete removal.

The grate shall be so arranged as to provide for expansion and contraction without distortion or displacement or damage to other parts of the furnace. Also, provision shall be made to eliminate adhesion of clinkers to the firebrick lining surrounding the grate area or areas.

Where dumping sections are provided in the grate area, they shall be so designed as to seat and unseat easily and quickly and when opened for discharge of residue they shall afford sufficient passageway for bulky residue of not less than sixteen inches in the least dimension. The operating device shall be such as to be conveniently located and capable of easy and quick manipulation.

Combustion Chamber.—The combustion chamber shall be designed of such dimensions and arrangements as to cause a "rolling" effect in the gas flow and a reduction of velocity of approximately ⅓ from that of the entering gases, but with gases at approximately 2300 degrees F. The flue from the combustion chamber shall be of such dimension as to conform to the arrangement for reduced velocity in the combustion chamber while providing for a free gas flow to the chimney with gases at approximately 2000 degrees F.

The chimney is to have a height sufficient to furnish the necessary draft without drawing up flue dust or partially burned solids, and sufficient area to provide free gas flow and prevent back draft. Forced draft equipment is to be provided, for use when necessary, capable to furnish 5 pounds of air per pound of refuse against a net static pressure of 3 inches; with pre-heaters for heating the air.

Ash Handling. The residue is to be discharged into ash pits, without causing dust on the firing or stoking floor, and be removed to vehicles with a minimum of labor and time, and of discomfort to the laborers from dust.

Tools for operating the plant will be furnished in duplicate, including slice bars, stoking hooks, steel rakes and hoes, 6 steel wheelbarrows, 12 iron scoop shovels, 12 rubbish forks, and 12 long-handle shovels.

Instruments to be provided include a pyrometer thermocouple in each furnace, the combustion chamber, flue passage to chimney, and in chimney 30′ from the floor all connected to multiple continuous recording pyrometer in the office; an indicating pyrometer with multipoint switch, installed on the furnace in a dust-proof case; and an electric CO_2 meter with controlling or sampling element installed in the chimney 30 ft. from the floor, with continuous recorder in the office, and large dial indicating instrument installed in the same case as the indicating pyrometer.

Unemployment Relief Drains Country Swamps

Most unemployment relief work appears to be devoted to municipal betterments or state highways, to judge by the printed reports; but Memphis and Shelby county, Tennessee, have taken the opportunity to help the farming sections of the county by eliminating malaria, in so far as this can be accomplished by such draining of wet areas as they can perform with the labor available.

Many dozens of wet areas or permanent sources of malaria-conveying mosquitoes are being drained. Trucks loaded with one hundred or more of the unemployed leave the city of Memphis early every morning and return at dusk after putting in the day at this work, which is being supervised by the county engineer department and the county and city health departments.

Similar work was started in Dyer county, Tennessee, one of the public spirited women residents furnishing the initiative in this case. Many counties, and even towns and cities, could permanently promote the health of their citizens by similar work, and give work to many of their unemployed thereby.

Type of mosquito-breeding areas which are being eliminated by drainage performed by the unemployed.

Ditch dug by unemployed drains ten acre swamp which required larvacidal treatment for years

Drying and Incineration of Sewage Sludge

More comments on Mr. Stilson's article on this subject are given herewith. Others will appear in succeeding issues.

NO ONE reading this contribution to sewage treatment can have any other reaction than that it is a well detailed analysis of the subject based on theoretical considerations. It should prove the forerunner of much added thought and lead the way to better sewage disposal.

From the practical operation point of view, I, for one, wish that all of the points taken as bases of operation were as easily accomplished as they are easily read. If sewage disposal could be reduced to the one subject—disposal of filter cake—perhaps we could make material progress toward those ideals Mr. Stilson has set forth.

Unfortunately, sewage is not only domestic wastes but a varying and complex mixture of household and industrial wastes. If the latter were absent, every State board of health could demand that every sewage treatment plant discharge effluent equivalent to drinking water, for this could be continuously and economically accomplished. Trade wastes have nullified many excellent theories of sewage rectification and their presence is a fact and not a theory.

When practicing chemical precipitation, it is well known that the dosage which is satisfactory at one plant is quite unsatisfactory at another. Hardness of ground water will alone vary the chemical dosing through a wide range. Generalisms based on a single plant's conditions are dangerous. The calorific power obviously varies with the ash content, which in turn varies through wide limits in the amount of chemical precipitates obtained in different locations.

The point of low temperature drying is correct but the job of venting air with 50% or 25% saturation at temperatures around 100° F. is costly. There is a very positive mean between fuel economy and overall drying economy, as is well known in the dryer art. Unless a conditioned air of relatively elevated temperatures, 180° F., is circulated, the humidity-carrying power is pitifully low and dryer economy similarly low. There is a vast difference in "material control" when circulating air above 500° F. and when the maximum temperature is under 300° F. The economical dryer evaporates the free moisture at such a rate that the temperature of the solids closely approximates the wet bulb temperature—always under 200° F. If any interruption in the passage of the solids through the dryer occurs, the scorching effect of gases above 500° F. is serious, from the odor control viewpoint. Under 300° F. this stoppage of the dryer might give rise to some distillation of unoxidized organics but never raises the stench of incompletely burned organics.

The argument against the use of paper might be conceded when based on "ash free" product. If in practice it actually cost money to incinerate the paper in the dewatered solids, the paper addition could still stand on its own feet. At Dearborn, the idea of the paper was developed to speed up the descent of the solids of suspension after chemical dosing. It works. I have seen comparative tests in which the paper loaded sample settled to a more brilliant supernatant in less than ½ the time that the other sample, without paper, required. The sludge dewatering at Rockville Centre requires paper amounting to from 30% to 40% of the dry untreated sludge solids. It would appear as though this would seriously impede incineration when carrying through with Mr. Stilson's reasoning. Yet without that paper admixture, the sludge, consisting of preliminary settlings inclusive of those solids ordinarily caught by fine screens and excess activated sludge solids, could not be discharged from the filter. The matting effect of the fibers with the sewage solids increases the strength of the cake so that it is completely discharged.

The only chemical used for conditioning is milk of lime, and no plant in the country has a cost of conditioning of equivalent solids approaching that at Rockville Centre. Perhaps on a "dry and ash free basis" paper is an impediment to economical incineration in some cases. In actual operation there is plenty of ash, especially after a heavy storm brings down to the plant tons of silt and other inorganics. Yet Rockville Centre has sent its sludge cake to the garbage incinerator and has burned it without extra fuel. A test was made with a full day's run of undried filter cake from the Rockville Centre filters in a suspended grate type of incinerator in a nearby Long Island village. It was on a rainy day, with a large percentage of the garbage, melons, grape fruit and other contrary materials. In that test the sludge was mixed with the run of garbage and rubbish and not a pound of added fuel was necessary to burn it. This is proof of the incineratability of paper-loaded filter cake.

In conclusion, I want to voice my commendations on the subject and scope of Mr. Stilson's paper and hope his exposition will lead more minds to think of the possibilities of better sludge cake disposal. We need more theoretical treatment of this subject in the hope that out of it will come better practical operation.

ARTHUR WRIGHT, M. E.

The heat balance of sludge and paper, given by Mr. Stilson, is commented on by Mr. Borge as follows:

The article in the June issue of PUBLIC WORKS entitled "Drying and Incineration of Sewage Sludge" calls—in this writer's opinion—for certain comments and corrections. This refers especially to the two heat balance calculations comparing wet sludge with the same material mixed with paper.

According to the article, 4.4 pounds of dry paper is to be added to 89 pounds of sludge having the following characteristics: 60% water, 16% ash and 24% combustible.

In other words, the new mixture will consist of 53.4 pounds of water, 14.24 pounds of sludge ash, 21.36 pounds of sludge combustibles and 4.4 pounds of paper which again will be divided into 90% combustibles and 10% ash or 3.96 pounds paper combustible and 0.44 pounds paper ash.

The percentage of the various components will then be:

Water	53.40 pounds		57.17%
Sludge ash 14.24 / Paper ash 0.44	14.68	"	15.72%
Sludge combustible	21.36	"	22.87%
Paper combustible	3.96	"	4.24%
	93.40 pounds		100.00%

For the purpose of comparison, the same figures and method of calculation are used as in the original article. It should be noted, however, that heat losses due to air infiltration and radiation have not been included.

HEAT BALANCE OF SLUDGE AND PAPER.

Heat to raise the water to 212° : 57.17 (212-60)	8,689.84
Heat to raise water to steam : 57.17 x 971	55,512.07
Heat to raise steam to 1400° : 57.17 x 0.48 x (1400-212)	32,600.62
Heat to raise ash to 1400° : 15.72 x 0.19 x 1340	4,002.56
Heat lost in dry chimney gases:	
[27.11+(27.11 x 18)] x 1340 x 0.24	165,652.94
Heat dissipated	266,458.03
Heat available in paper : 4.24 x 8,200 =	34,768
Heat available in sludge : 22.87 x 11,500 =	263,005
Heat available	297,773

Heat Excess : 297,773 — 266,458=31,315 B.T.U's.

The adding of the paper to the sludge has therefore resulted in a gain of 31,315 — 23,681=7,634 B. T U's. instead of a loss of 5,697 B. T. U's. as given in the original article

J. BORGE, *Consulting Engineer,*
Sanitation Engineers & Constructors, Inc.

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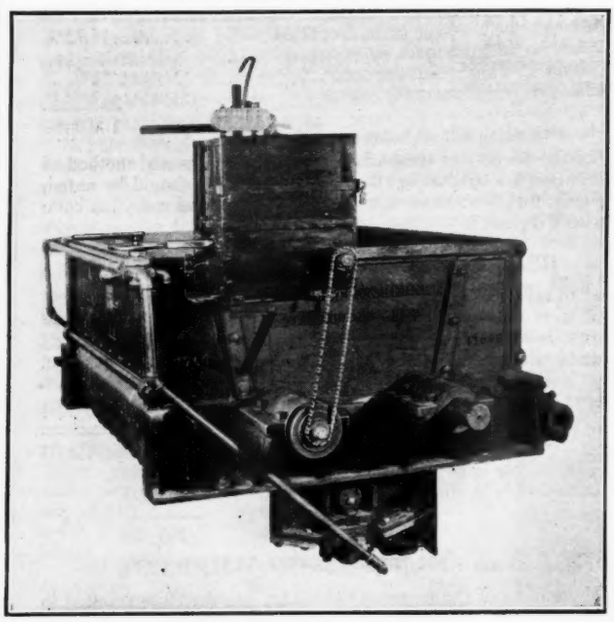

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Road Maintenance Details in Kansas

For maintaining bituminous mat roads in Kansas, two men are assigned to each section of about 30 miles length. They are provided with a 2-2½ ton truck, with a 2-yard body, and a tool box, and a roller. The maintenance of the bituminous mat consists of two major items. First, of course, is the patching and care of the surface if any defects should develop. Stock piles of unmixed aggregate and barrels of oil are placed at intervals of approximately 5 miles and a small concrete mixer is available for the sectionmen to use in mixing these materials for patchwork. Later operations have shown that it is more economical to remove a few cubic yards of the bituminous materials during construction from the mixed windrow before the mat is laid down and placed in storage piles each mile or two for future maintenance repairs.

Surface defects of a minor nature are usually repaired by simply sweeping the loose material from the hole and filling it with the stock-pile bituminous mixture or by sprinkling a light coat of road oil over the defect and "blotting" it with sand-gravel, chat or limestone of the proper gradation. All patches should approximate the original treatment in quality so as to produce a uniform and stable surface.

Where an appreciable length of section shows signs of general deficiency it is torn up, remixed and oil or aggregate added to produce the proper stability. This more extensive work is not handled by the sectionmen, as it involves the use of considerable equipment and is supervised by a foreman experienced in this class of work.

The second, but not the least, important item of maintenance is that of shoulder rolling. Stability is produced in the sections of mat which carry the traffic due to the movement of vehicles over it, but the portions which remain outside the traveled way are apt to become loose and porous unless they are rolled frequently. The porous condition permits the absorbtion of moisture, which not only deteriorates that part of the road but penetrates under the edges of the main section of the mat. This frequent rolling is a requirement of the sectionmen which has proven most beneficial to the general condition of the bituminous surfaces.

Manitoba 300 HP Snow Removal Unit

A 300-hp snow removal unit has been purchased by the Province of Manitoba from the Four-Wheel-Drive Auto Co. The average snowfall in Manitoba is 56 inches, and due to climatic conditions, the snow becomes hard packed and difficult to remove from the highway, so that light equipment is often unable to cope with the problem of removal.

The new unit is a 7½ to 10-ton model equipped with two 150-hp. engines. One of these drives the truck, while the other operates the rotary snow plow. However, either engine may be used for driving the truck, and for light snowfalls, the forward engine is sufficient to operate both the truck and the plow. When desired, the auxiliary engine, which is located in the bed of the truck, can be removed, and the truck used in the regular manner. A dump body and a hoist are part of the equipment, and it is expected that the truck will be used regularly on highway work, except during the winter.

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ONLY GOODYEAR gives you *patented pre-shrunk* **Supertwist** *cord construction*—assuring *durability and protection against blow-outs.*

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For latest industrial literature, consult the *classified* Readers' Service Dept.—pages 47-49.

Solution of a Troublesome Culvert Problem

By Jay Perry
Commissioner, Benton County, Washington

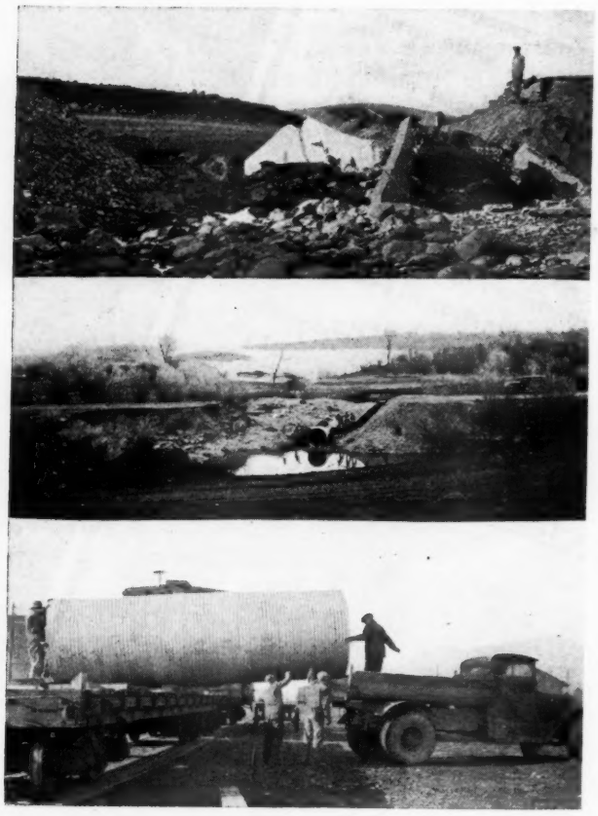
SIX miles west of Kennewick, Washington, and about a mile and a half above the junction of the Yakima river with the Columbia, is our county highway leading off to the right from State Road No. 410 up to Richland. This is a black-top surfaced road built on a fill of ten to twelve feet which also serves as a dike when high water in the Columbia backs up the Yakima and covers several sections of land in this vicinity. Openings have of course been provided through this dike to allow water which collects above it to find its way back to the river. One of these openings, about a quarter of a mile from the state highway, has had an interesting history.

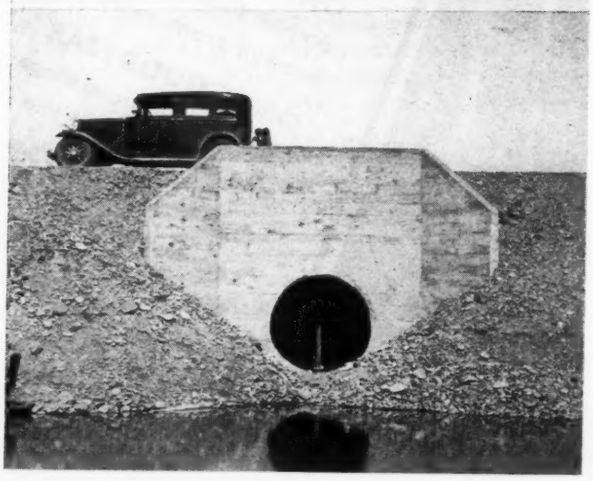
The original structure, of concrete with a waterway perhaps 12 feet wide and three or four feet deep, was replaced in 1929 with another concrete bridge 8 feet wide and about 6 feet deep. This later bridge had a reinforced top but only the natural ground for pavement, it being believed that the soil was stable enough to support this type of bridge and would be satisfactory without paving.

This functioned satisfactorily for 9 years, but last December, when this section of Washington, along with the entire northwest, was visited with one of the worst floods in its history, the Yakima backed up higher than ever before and came within inches of overtopping the road. The bridge foundation became so soft that the walls began to settle, and the water on the upstream side started to cut through the fill, and once started it was just a matter almost of minutes until approximately a hundred feet of this 10-ft. fill was washed away. This provided sufficient opening to relieve the pressure, and the rest of the fill was saved. The entire bridge had settled about three feet, and above it a hole 60 to 80 feet in diameter and several feet deep had been washed out.

It was obvious that the new culvert should not depend so much for its stability on the uncertain foundation the soil provides here and must certainly have a bottom as well as a top and sides. The absence of a bottom in the old bridge was probably the greatest factor in its failure. With this in mind, and the necessity of repairing the road as rapidly as possible, it was decided to put in an Armco corrugated culvert, 72 inches in diameter, with headwalls wide enough and high enough to discourage any flow of water through the fill near the pipe.

The pipe, 36 feet long and 72 inches in diameter, was





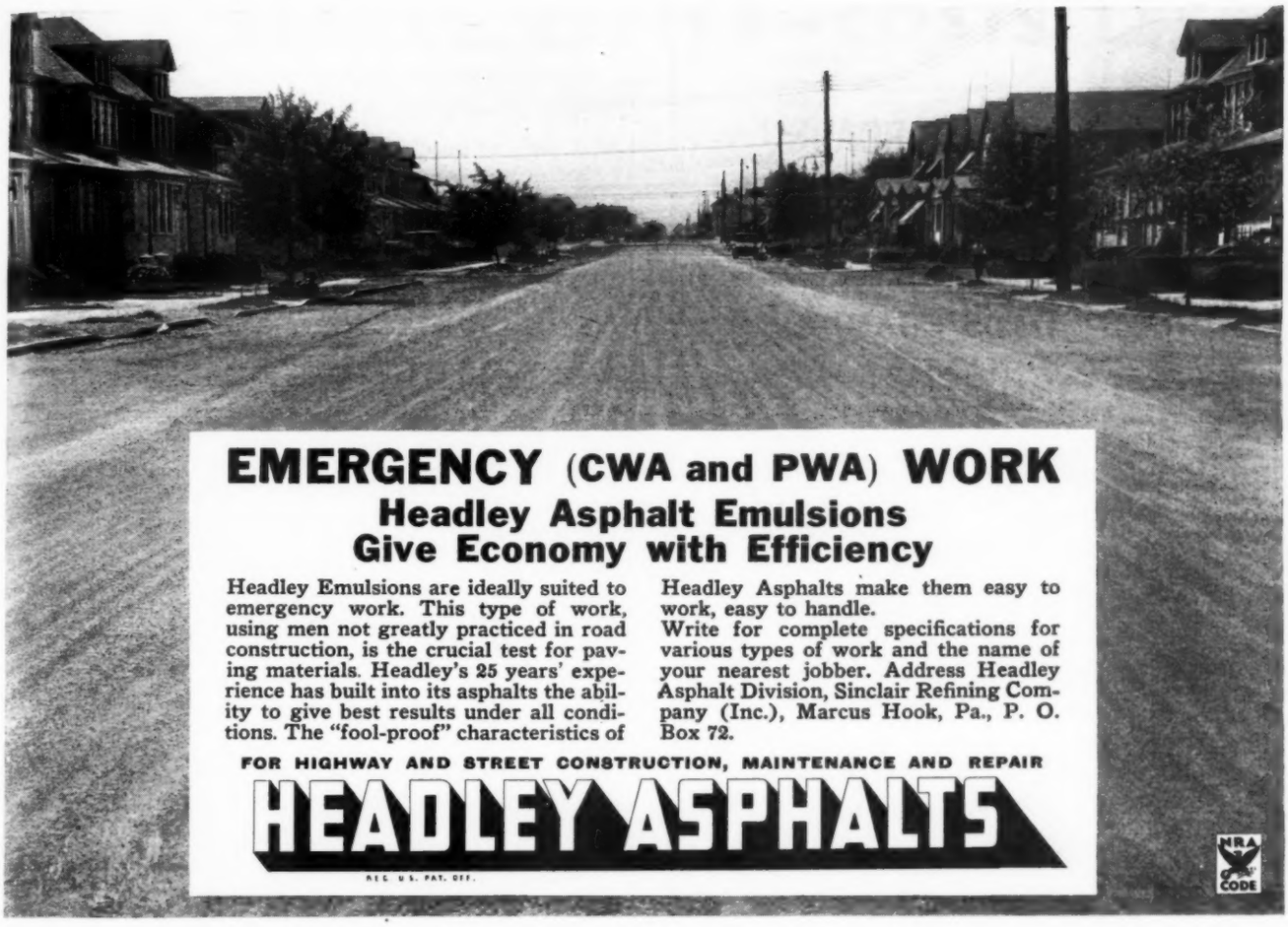
UPPER LEFT: *View of washout from lower end. Bridge crew has begun breaking up concrete to salvage steel for reinforcing new headwalls.*

MIDDLE LEFT: *View of washout from upper end. Washed-out pool in foreground. River in background. About 30 ft. of washout has been refilled on the right.*

LOWER LEFT: *Loading 72-inch pipe from flat car to truck*

TOP ABOVE: *Pipe in place, with fill being tamped around it.*

LOWER RIGHT: *End of finished culvert, showing temporary strut. (The use of temporary struts in large-diameter pipe increases its strength and improves its final appearance.) The horizontal wires are a wire fence*



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Write for complete specifications for various types of work and the name of your nearest jobber. Address Headley Asphalt Division, Sinclair Refining Company (Inc.), Marcus Hook, Pa., P. O. Box 72.

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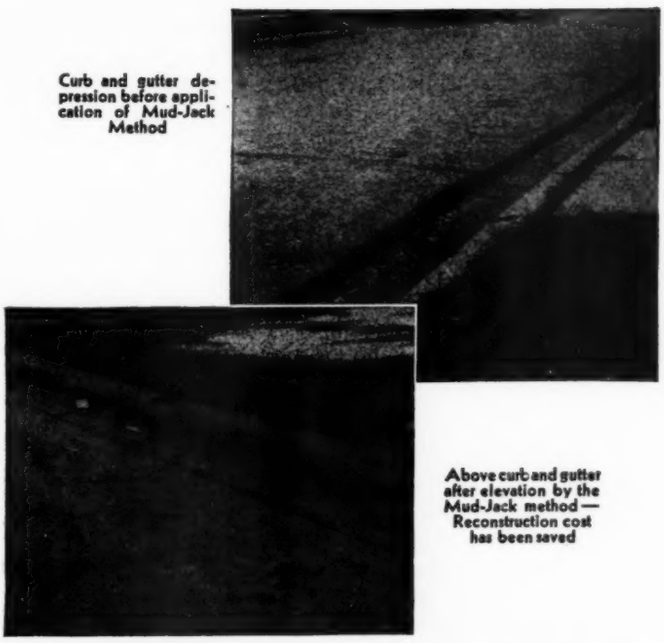
MUD-JACK METHOD



Curb and gutter depression before application of Mud-Jack Method

Above curb and gutter after elevation by the Mud-Jack method—Reconstruction cost has been saved

Raises Sunken Curb and Gutter

A typical curb and gutter depression is illustrated, before and after the application of the Mud-Jack method . . . This is accomplished without the usual costly reconstruction method . . . No need to destroy the concrete.

The Mud-Jack pumps mud, mixed with cement for setting, through drilled holes in the concrete, thereby building a new subgrade and raising the project to the original grade.

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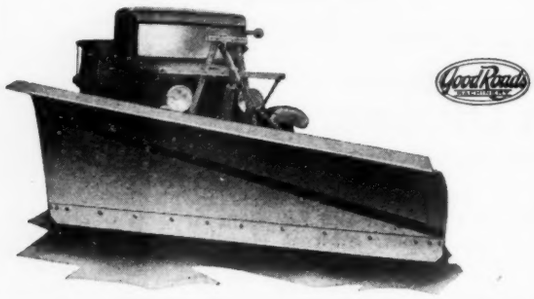

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ordered one afternoon and was shipped two days later from Spokane, where it had been fabricated. It came in two 18-ft. sections with a connecting band, and pretty well covered one flat car. We were a little concerned about hauling it out to the job, for, although each length of pipe weighed only a ton and a quarter, our truck bodies were only a little over nine feet long with high sides and it looked as though we might have some trouble transferring the pipe from the flat car to the trucks. As it turned out, this was a very simple job.

The scheme we used was as follows: We rolled a section onto an eight-inch square timber, and, having it just balanced there, spun it around until one end overhung the side of the car, and then backed the truck under it. Roughly, 9½ feet of each section rode on the truck body while the other 8½ hung over behind. To make sure it would not fall off the truck, we roped the front end down, although it is doubtful if this precaution was necessary. Handled in this manner, three or four men could do the work easily.

The trucks had dump bodies, and when they had reached the site of the job the drivers simply hoisted the bodies until the overhanging ends of the pipes touched the ground, then drove carefully forward, allowing the pipes to slide easily to the ground. Then, with a small cable around a pipe and fastened to one of the trucks, it was lowered into the trench easily and so accurately that it required only a little shifting to bring the two ends together and make the connection.

Dirt for the backfill was trucked in from a nearby field and was dumped on the right hand side and was then shoveled in around the pipe on both sides and tamped very carefully in place. This tamping was carried up halfway on the pipe, after which the fill material was simply shoveled over it, to be compacted later by the trucks traveling back and forth as the fill was brought up to grade. The pipe was strutted vertically about two and one-half inches out of round to insure against undue deflection while the backfill was being made, the struts being left in until the fill had a chance to settle for a few weeks. The headwalls then were built and the fill completed.

All this work was carried on under the direct supervision of A. W. Wall, our road and bridge supervisor. We are certainly well pleased with the rapidity with which we got this troublesome situation cured, and believe it was done in the most sensible and economical manner possible. If there is anything in the theory that the third time is the charm, then our troubles at this point should be over.

Sludge Collecting Apparatus at Milwaukee

The Milwaukee sewage treatment plant is being enlarged at a cost of $2,500,000 to increase its capacity from 85 mgd to 155 mgd average, with a maximum of 233 mgd. As a part of this extension, the original fifteen sedimentation tanks will be increased by six tanks, each consisting of two chambers 84′ by 161.5′, and there will be twelve additional aeration tanks each 42′ 9″ by 370′.

The sedimentation tanks will contain sludge-collecting apparatus of the Tow-Bro type, developed by Darwin W. Townsend, consulting engineer to the Milwaukee Sewage Commission, and James Brower, superintendent of the Milwaukee treatment plant; which will have various improvements and refinements over similar apparatus used in four of the present tanks. This type of collector (described in PUBLIC WORKS for September, 1932) is being furnished under contract by the Chain Belt Co.

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First Paved: **1894.**

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Maintenance: **Nil to practically none.**

Relaid: **1934.** ***Labor:*** **CWA.**

Salvage: **75% of original brick.**

Authority: **Roy S. Garrett, Assistant City Engineer, Montgomery, Ala.**

Data Published by: **National Paving Brick Association, Washington, D. C.**

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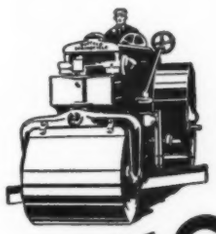
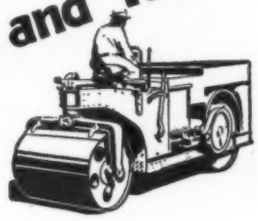


BUFFALO-SPRINGFIELD Three Wheel and Tandem



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For latest industrial literature, consult the *classified* READERS' SERVICE DEPT.—pages 47-49.

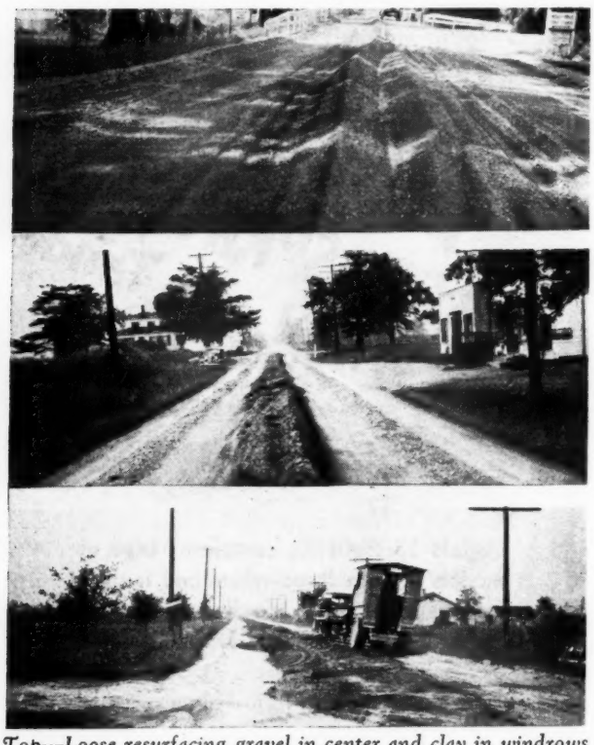
Stabilization of Resurfacing Gravel In Oakland County

By Leon Belknap, Engineer-Manager, and John Barr, Project Engineer, Oakland County Road Commission

OAKLAND county, Michigan, is located largely in the metropolitan area of the City of Detroit. Its highways carry considerable traffic during the summer seasons, due to the may lakes situated within its borders. At present there are in the county some 420 miles of hard-surface pavements and 375 miles of gravel-surfaced highways.

As there was little money available for maintaining this mileage during 1933, maintenance of the highways, and especially of gravel roads, fell below the standard of previous years. For this reason it was thought advisable to select some type of low-cost road surface which would prove more satisfactory than gravel as commonly applied, in order to meet conditions of traffic as well as reduce the annual cost of upkeep.

The gravel roads in the county were originally constructed with nine feet width and eight inches depth of compacted gravel, but on very few miles was there left sufficient material for either bituminous surface treatment or stabilization with clay. Resurfacing with loose gravel 1½ in. thick for 20 ft. width would not reestablish a surface of more permanent nature, due to inadequate base. Finances would not permit of the usual channelling of sub-grade and widening of the base with gravel to the required 8 in. by 20 ft. of compacted materials. It was decided, therefore, to add sufficient new material to the loose gravel on twenty miles of highway to give a covering at least 3 in. deep for 20 ft. width and to stabilize this with a clay binder. This required from 500 to 1,000 cubic yards of gravel per mile of road. Seven projects were selected, located in various parts of the county, on which the summer traffic varies from 300 to about 3,000 vehicles per day.



Top—Loose resurfacing gravel in center and clay in windrows on shoulders

2nd—Clay delivered in two windrows between wheel tracks on road with resurfacing gravel in center

Bottom—Spreading gravel from center windrow. Pulverized clay on shoulders

Locating and Grading Materials

The first step was to locate adequate materials in proximity to the various projects. Gravel deposits were abundant, but locating the required quality and quantity of clay was difficult. (Clays used for this work should have a plasticity index of 18 or more.) Most of the clay banks contained such small quantities as to make them uneconomical for use. A systematic survey of the whole county was made and many clays were analyzed, aided by the Road Stabilization Department of The Dow Chemical Company, which placed at the county's service its field laboratory and a man skilled in soil analysis. This laboratory tested over 175 samples of clay and gravel during the season and prepared accurate laboratory reports concerning their quality. Approximately eighty samples of the clays tested showed a plasticity index of 17 or better, but in only three localities did the quantities exceed 200 cu. yd., and these were at considerable distances from the projects. However, as the plasticity index of the three clays ranged from 23 to 33, the amount required on each job was less than with clays of lower plasticity index, so that the longer hauls to the various projects were warranted.

Mechanical analyses were made of the different gravels to determine the suitability of each for road metal, and to find whether other materials must be added to give it the proper grading. Specifications prepared by the Calcium Chloride Association for stabilized wearing courses require 25 to 35 percent of soil fines in the gravel. (The soil fines fraction consists of the screenings passing a number 40 sieve, and is composed of clay, silt, and fine sand.) Laboratory mixes were made by combining definite proportions of the gravel that was to be stabilized with the clay that was to be used on each particular project, and the proportions of materials were adjusted until a plasticity index of 8 to 10 was obtained. It was found that the amount of clay necessary for the different projects varied between 2½ and 4 cubic yards per 100 ft. length of roadway.

The gravel used on the South Holly project contained only 11% to 14% of material passing the number 40 sieve, and tests indicated that bank sand to an amount equal to 10% of the weight of gravel should be added. However, the gravel contained a large percentage of coarse sand passing the 20 and retained on the 40 sieve, and since the addition of bank sand would increase the cost appreciably, it was decided to experiment with several sections of this road, varying the amount of fine sand added. In the case of the highest percent of coarse sand and low percent of soil fines, it was decided to use a plasticity index of 11 to 12 instead of 9 to 10. Since this plasticity index is measured on the material passing the number 40 sieve, this provides

an allowance of clay to cover the coarse sand which is not included in the present tests for the plasticity index. Accordingly, a section 1,000 feet long was built without increasing the sand content, 1¼ miles was built using 5% additional sand, and one mile was built with the estimated necessary 10% of sand. This project was completed late in October so that a comparison of results between sections is not as yet obtainable.

Stabilization Methods

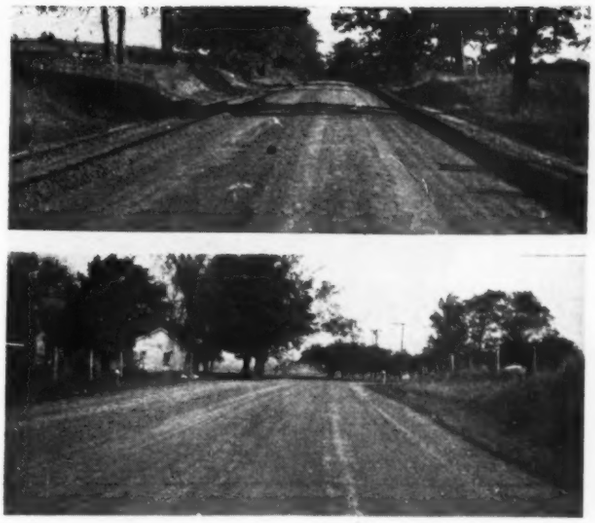
Placing of Materials.—As the first step in construction, gravel sufficient to resurface one-half mile of road was placed in a windrow along the center of the highway. Clay was then hauled and distributed in windrows along the shoulder lines and allowed to dry. On a narrow road, the windrows of clay were placed between the wheel tracks. The tail-gates of the trucks hauling clay were arranged with the opening reduced to allow clay to be discharged as uniformly as possible, this being checked by the amount of material actually unloaded between 100-ft. stations. The time required for drying varied with weather conditions and with the amount of moisture in the clay when it was placed. During drying weather, usually from 24 to 36 hours were required.

Late in the season, rains came with such frequency that the large windrows of gravel retained a considerable amount of moisture. This made mixing more difficult; so it was decided that, for the remainder of the year, the gravel should be spread evenly over the surface of the road so that it would be partly compacted, and hence not hold water.

Pulverizing of Clay.—As soon as the clay became dried it was spread by means of motor-graders, floated lightly with a truck blade until it was thoroughly pulverized, and then pushed back to its original position on the shoulders.

Mixing.—The gravel which had been windrowed in the center of the road was then spread between the two rows of clay, and the clay was then bladed uniformly over the road. Where the gravel had been spread over the surface of the road instead of windrowing it in the center, the powdered clay was spread evenly over this partially compacted material and a motor grader made two or three trips with the scarifying teeth lowered to make sure that the gravel was loosened to the full 3-inch depth. The motor grader then mixed the materials by blading them toward the shoulders, then back and forth across the road until the clay was thoroughly incorporated in the gravel. The resulting mixture was then bladed in windrows on either side of the road, where it was ready for spreading and sprinkling. It usually required about seven hours to pulverize and dry-mix a one-half mile section of this road, using two motor graders and two trucks.

Spreading and Sprinkling.—Some of the stabilization projects previously constructed had depended on rainfall for water, and the final shaping process was delayed until after the first rain. During 1933, however, we used a 1,000-gallon tank truck to furnish water for the mixture during dry weather. This made it possible to continue the work without hindrance to traffic and to reduce the amount of dust nuisance promptly. The speed of the truck was regulated so that one-half mile could be sprinkled in a round trip. After the base of the road had been moistened uniformly, a small amount of the mixed material was bladed from the windrows on to this surface, and then similarly moistened and covered as before, and these operations were repeated until all of dry material had been



Top—Part of wearing course mixture placed, moistened, and partly compacted, with balance of dry mix on shoulders
Bottom—View of Davisburg road, fall 1933, after 1½ years of service

placed. This method proved more satisfactory than spreading all of the mixture on the road at one time and then attempting to wet the materials sufficiently from the top, which method did not produce uniform moistening, dry pockets sometimes forming which later caused ravelling of the surface. The first method required five to ten tanks of water more than the latter method, but the improved results that were obtained warranted the additional cost.

Occasionally after the clay had been spread over the gravel, rain wet the material before it had been thoroughly mixed. As the clay at this period was in such condition as to slake as soon as it came into contact with the water, mixing was continued until all sand and gravel particles had been coated with a clay film. During a part of the summer sprinkling was done during the night, to eliminate interference with traffic and reduce the amount of evaporation of moisture from the mix. However, during the latter part of the summer and fall sprinkling was performed very satisfactorily during the day, as it was found that traffic helped to pack the separate layers of gravel. After the last of the material had been spread from the windrows, the surface was bladed until the proper crown had been obtained and it was then thoroughly dampened and allowed to be compacted by traffic. The amount of water used per one-half mile varied from 7,000 to 15,000 gallons. Smaller amounts would have given fair results but the water supply was near the project in all cases and the expense was low, so an ample quantity was used.

If, after shaping and smoothing, the surface showed signs of pitting or ravelling (caused sometimes by non-uniform application of the water or by poor mixing of materials), the surface was moistened by sprinkling and the roughness was eliminated by motor graders. Calcium chloride was then applied to the smooth, hard, damp surface at the rate of two to four tons per mile.

As soon as each project was completed, a check was made to determine the plasticity indexes of the various wearing courses. The average of the seven projects showed a plasticity index of 9, the figure originally desired.

Construction Costs

Costs on these seven projects varied according to the quantity of gravel used, length of hauls of clay and

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gravel, and time required to pulverize clay. This last item depended to some extent on weather conditions, since rains sometimes required additional working of the clay. The cost per mile of construction varied, as indicated in the table, from $842 on the Beaver Road to $1,344 on the South Holly Road. The average cost for the seven projects was $1,085 per mile. These total costs are somewhat high for clay and gravel reconstruction; however, under normal conditions of maintenance, it would not have been necessary to add such quantities of gravel at one time as were used on these projects.

Project No.	*Plasticity Index of Clay*	*Average Clay Haul, Miles*	*Aver. Clay per Mi., Cu. Yds.*	*Aver. Gravel per Mi., Cu. Yds.*	*Aver. Haul of Gravel, Miles*	*Aver. Total Cost per Mile*
148	23	13	160	500	3.5	$ 842.65
46	17 to 20	6	200	1000	3.3	1,045.00
149	17	4.2	250	800	9.5	820.00
144	28	17	180	1000	7.5	1,129.00
147	23	8.5	120	900	7.0	1,135.60
151	19 to 24	5.5	200	850	7.0	1,278.00
150	20	3.2	160	700	5.8	1,344.00
						$7,594.25

$7,594.25 divided by 7 (7 projects) = $1,085 average per mile

The higher costs on the South Holly and Rochester roads than on other projects were due almost entirely to the fact that both jobs were carried on late into October. There was no opportunity to acquire compaction of material during the wet season, so that additional grader work was required. For this reason it does not seem advisable to carry on this type of work beyond late summer or early fall.

Since this type of construction is new to Oakland County and such a short time has elapsed since construction, very few cost data are available concerning maintenance. However, on those projects completed during midsummer, very little blading or patrol work has been necessary. Since the hardness of surface does not permit of grading during dry weather, any irregularities that have developed were eliminated by blading after a rain.

During the fall of 1932 a 3½-mile project was constructed on the Davisburg road, on which only 100 cubic yards of clay per mile was used. There is more loose pebble floating on the surface of this project than on those where a higher amount of clay was used. It has, however, been giving excellent results for about 1½ years. During the early summer of 1933 this road was scraped only twice. This shows that there is a decided saving in blade maintenance. It is obvious also that the firmly bound surface will reduce the future loss of gravel.

At the present time, most of the 1933 projects are in very good condition. The surfaces seem to be very well bound together and relatively smooth. Here and there a few chatter bumps have developed, which will easily be eliminated as soon as weather permits. Some time ago a few miles showed a thin floating cover of loose pebbles, but today that condition is eliminated and the pebbles are incorporated into the surface. With few exceptions, all surfaces are smooth and free from loose material. As soon as spring rains subside, surfaces will be bladed and allowed to compact, at which time a light application of calcium chloride will be applied. All of the stabilized roads in this county are now satisfactory and promise to remain in good condition with a minimum expenditure of maintenance money.

TABLE 2.—*Operating characteristics of large scrapers*

	Scraper Numbers							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Rated capacity ..... cubic yards..	3	6	8	4	5	4	4	5
Condition of equipment	Good	Very good	Very good	Very good	Very good	Fair	Good	Fair
Number of round trips timed.....	212	269	132	145	54	56	3,200	963
Loading distance ..... feet..	75	116	144	80	86	92	100	38
Loading speed ..... feet per second..	2.3	1.8	2.0	2.1	2.0	1.8	2.0	2.3
Hauling distance ..... feet..	180	327	290	210	372	1,400	300	237
Hauling speed ..... feet per second..	2.9	3.5	2.8	3.0	3.2	3.0	2.5	3.3
Return distance ..... feet..	254	405	449	280	450	1,450	400	275
Return speed ..... feet per second..	3.2	3.8	3.8	3.7	3.8	4.7	5.5	2.7
Dumping time ..... seconds..	10.4	....	....	....	46.0	34.0	11.0	10.4
Turning time ..... do..	18.0	22.0	20.0	24.0	27.0	22.0	20.0	....
Size of load carried to dump, percentage of apparent full load....	95.0	75.0	50.0	90.0	61.0	75.0	90.0	....
Average pay yardage in percentage of rated load capacity.....	57.0	45.0	35.0	54.0	37.0	45.0	53.0	44.0

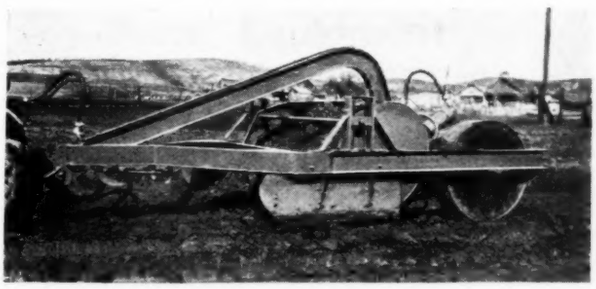
The Use of Large Scrapers in Highway Grading

By Andrew P. Anderson
Highway Engineer

Continuation from July issue of Report by Division of Management, Bureau of Public Works

LARGE tractor-drawn scrapers have been studied on a few grading jobs having large quantities of short-haul common excavation. These scrapers ranged in rated capacity from 3 to 8 cubic yards of loose material and were of six different makes. This equipment is far from standardized. However, those observed may be divided into two distinct classes: Those which carry the load pan or scoop clear of the road, and those which drag the load pan or cutting blade so as to transport a part or all of the load by pushing it ahead of the pan or cutting blade.

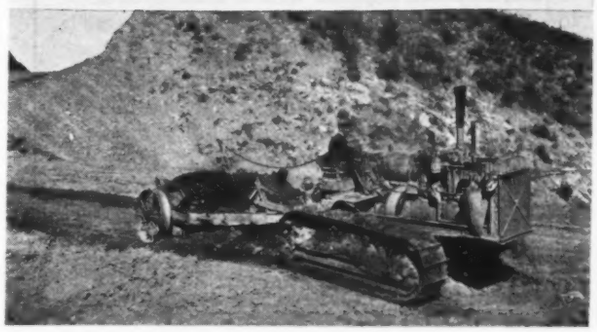
Some of those which lift the pan have definite provisions for preventing or reducing spillage while the load is being hauled to the dump. These provisions vary from substantial self-closing gates to simply tilting the load pan to such an angle that the tendency for the material to spill out is greatly reduced. In the other class, the pan is raised very little for the haul and spillage is prevented or at least neutralized by accumulating and dragging material in front of the pan.



Scraper with full load and pushing earth before it.

Adjusting the pan so as to drag material produced a considerable effect on the hauling speed. When the scraper was hauled with the load pan clear of the ground the hauling speed was generally 30 to 50 percent higher than when the pan dragged sufficiently to retain a full load. The effect of reduced speed, however, seemed fully compensated by the increased load. With the pan hoisted entirely clear of the roadway, the loss from spillage on steep or rough down grades was as much as one half of the original load when the soil was dry and noncohesive. Considerable difficulty was sometimes experienced in dumping the gate type of scraper when working in sticky or plastic materials.

Results of observations on four jobs using six different types of scrapers are shown in table 2. Scrapers 1, 2, 3, 4, and 5 were all on one job and operated under fairly similar conditions. Job 7 was observed only in the winter when the materials were wet and sticky.



Top—Type of scraper which dumps by overturning on front shoes. Middle—Scraper without front closure in loading position. Load is dumped by use of cable which pulls back plate forward. Bottom—Scraper arriving at dump with full load.

The Water Wheel

FOLLOWING are the essential features of the important articles of the month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted. Published every month to include articles appearing during the preceding month.

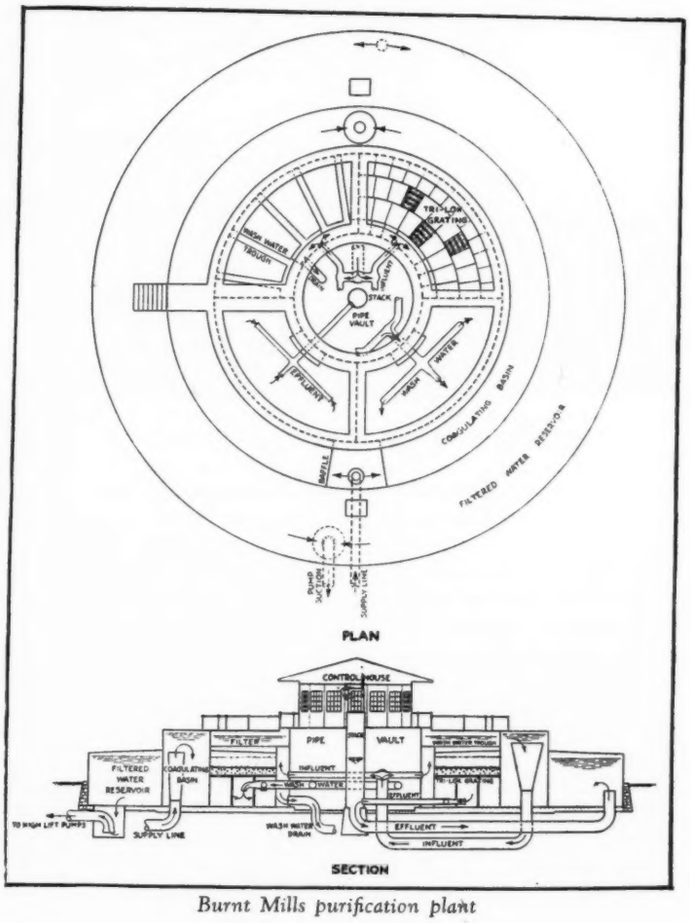
A UNIQUE purification plant layout—perhaps the first all-round plant—is under construction by the Washington Suburban Sanitary Dist. at Burnt Mills, Md.[G7-3] A 5 mgd plant—pipe vault, filters, coagulating basin and filtered-water reservoir—fill a circle of 100′ diameter. In central cylinder 24.5′ diam., with control house on top, is operating piping. Between this and a concentric wall 54.25′ diameter are 4 filters separated by radial walls. Between these and a concentric wall 72′ diameter is the coagulating basin. Between this and the 100′ circular wall is the filtered water reservoir. A preliminary sedimentation basin would have been located in annular ring between coagulating basin and filtered water reservoir had the space been available. All the circular walls rest on a concrete slab, and are of structural steel plates and shapes welded together giving notable economy in both cost and space. The shells surrounding the filters and coagulating basin are 14.5′ high; outside ring of filtered water reservoir, 10′ high. The filters are left uncovered. The control house is heated by electricity. The filter gravel rests on floor of "Tri-Lok" grating, composed of galvanized copper-bearing steel. The water will pass through Aer-O-Mix aerators; 3 hours in preliminary sedimentation tanks; receive coagulant and activated carbon and 55 minutes in coagulating basin; through filters to filtered water reservoir.

In residual chlorine determination by the standard orthotolidine procedure "the presence of manganese and nitrites may cause large errors or even render it impossible to decide whether any residual is actually present.[A7-8] The author describes a method, using magnesium sulphate together with sodium hydroxide in excess, "for eliminating manganese interference by its complete removal from the water"; at the same time nitrite interference is much lessened and its effect may be measured with considerable accuracy. If nitrite nitrogen exceeds 0.2 ppm, "residual chlorine is most safely determined by the starch iodide procedure described" in the article.

Repairing meters may be required by stoppage due to: 1—Scale on the chamber and disk; 2—wear in the intermediate trains (spur gear staffs, teeth, etc.); 3—wear in change gears. To replace only the badly worn parts is not economical, as the new and old gears will not mesh accurately and the meter registers inaccurately—generally slow. A full set of spur or train wheels or both change gears should be replaced.[DD7-10] "In the meter repair shop of the Dallas City water works, the average time taken to open, clean, replace and test a 5/8 inch meter is 50 and 55 minutes" (7,000 to 9,000 meters a year are repaired in that shop).

Even small plants should have at least one man who can repair meters; "it would be surprising how many meters could be repaired during the course of a year by proper utilization of so-called idle moments." Let such a man have a week's training in "one of the large water works meter repair shops in his territory," alongside experienced men under actual meter shop conditions. The equipment in Dallas comprises only "ordinary hand tools, a motor-driven buffer and grinder and a meter testing equipment."

The equipment in Newton, Mass.,[G7-2] comprises wash trays, lathe, testing equipment for meters up to 2″, work benches for 4 men, hooded acid tanks (for cleaning brass parts), storage racks, compressed air and gas outlets, motor drills and grinders; and in the basement 2″ and larger are tested, using calibrated tanks of 1.5, 16.0 and 120 cu. ft. capacity with piezometer rings and manometer. In this plant each meter is tested at its maximum rate, at half this, and at the smallest at which it will register, before it is repaired as well as after to provide records for meeting complaints of increased water bills. Testing and repairing two-thirds of all



Burnt Mills purification plant

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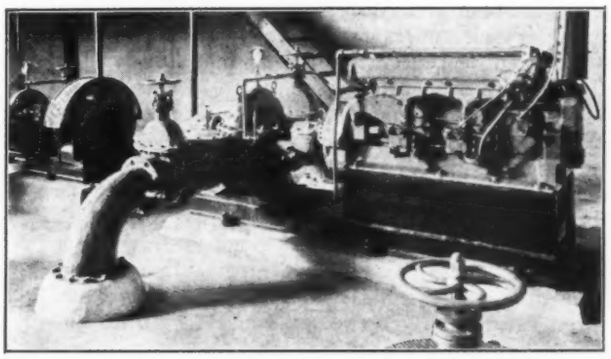

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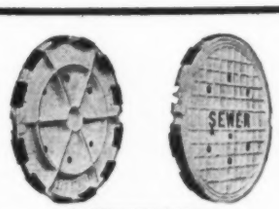

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For latest industrial literature, consult the *classified* READERS' SERVICE DEPT.—pages 47-49.

meters has increased meter registration and revenue by 12%, and 18% is expected by the completion of the testing program now under way—four times the cost of inspection and repair work. The average cost of repairing 2,600 ⅝ in. meters (without charge for shop overhead, records, etc.) is $1.07; 54.8 cts. for parts and 52.4 cts. for labor.

Coagulation and temperature are intimately related, according to C. J. Velz.[L8-4] Experimenting with Newark, N. J., water he found that "The strong correlations between alum dose and temperature, and between alum dose and raw water color, appear to show that hydrogen ion concentration has minor significance. . . . Increase in temperature requires an increase in the amount of coagulant and decrease in temperature permits a decrease in the amount of coagulant. . . . The summer dosage is found to be from 1.6 to 2.2 times that of the winter dosage." These results were based on using the minimum economical alum dosage required to produce a color in the basin effluent of 20 ppm, the raw water having a color of 34 to 38 ppm. Temperature appeared to have little effect below 14° C, the amount of alum required varying only between 0.9 and 1.1 grains per gal., but between 14° and 24° the amount required varied from 1.1 to 2.1 grains, definitely correlated with the temperature.

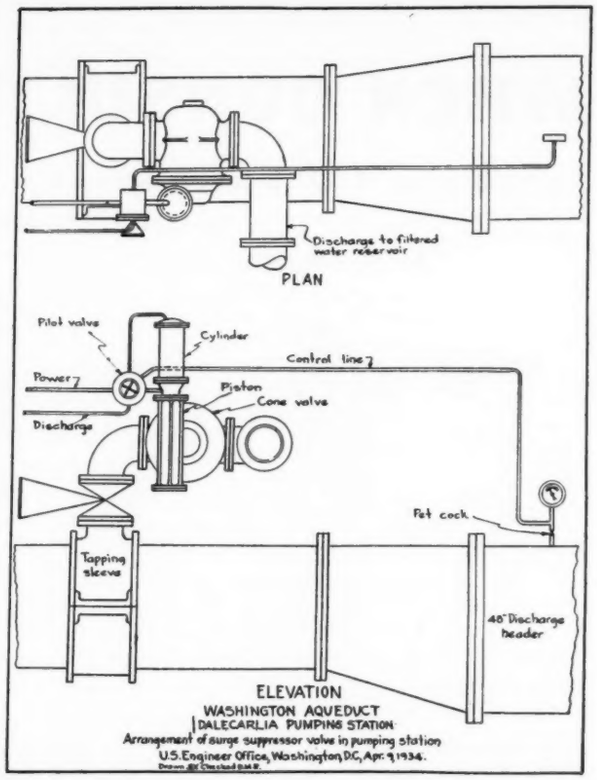
Concerning the relation between temperature and optimum pH, he found that at summer temperatures the optimum varied little from 5.4, but in winter excellent results can be obtained with a pH up to 6.7.

Using chlorinated copperas alone, floc formed rapidly with pH between 3.8 and 4.8 and between 8.0 and 10.0, but with the latter there was no removal of color whatever. It was therefore necessary to add large quantities of acid to effect color removal. But "a combination of chlorinated copperas and alum proved to be far superior to either coagulant alone."

Relining mains after cleaning by the "Eric" process has been in use in England for three or four years.[M7-5] After cleaning a main by scraping, a section 500′ or 600′ long is filled with "a special colloid solution of bitumen." An electrode is then drawn through the pipe by stages; at each stage electric current passes from the electrode to the pipe wall, causing bitumen to be deposited on the latter. When sufficient thickness of bitumen has been deposited on all parts of the pipe opposite the electrode (which is indicated by failure of current to flow) the electrode is drawn ahead and the process repeated. When this length of pipe has been coated, the coating fluid is pumped out and the main flushed. The bitumen imparts no taste, odor or color to the water.

12-Foot precast concrete pipe is being made by the Los Angeles Metropolitan Water District for comparison with monolithic concrete, a trial section of each about 700 ft. long being made, the former by contract by the United Concrete Pipe Corp. and the American Concrete & Steel Pipe Co., the latter by district forces. The 12-ft. pipe is believed to be the largest ever made.[E8-1] It will have 12″ shell thickness, reinforced to withstand a maximum head of 118 ft. The joints will be the Lock Joint lead gasket type. For heads less than 80 ft. reinforcement will be cage type, two cages of ½ in. bars; for over 80 ft. head, two cages and a cylinder of 10-gauge steel electrically welded. Each unit will be 12 ft. long and weigh about 40 tons.

Booster pumps may be used to materially reduce operating head on main pumps if used to provide head in



Sketch showing arrangement of tapping sleeve and surge relief valves

small sections of high elevation.[A7-3] By using small, inexpensive centrifugals as boosters and turning down impellers of main pump to reduce head, considerable saving in power will often be obtained. At Trenton, N. J., direct pumping by boosters was found preferable to use of standpipes, and four units of 1, 2, 3 and 4 mgd capacity, automatically thrown in and out of service, preferable to throttling a single pump of high capacity.

Surges in pipe lines have been practically eliminated in Washington, D. C., although quick-closing check valves on pump discharges had caused surges 175% above normal working pressures several times a year.[G6-1] Check valves of the hydraulically operated, rotary plug type were installed, equipped with an adjustable timing feature to provide means of regulating the speed of closing. Tests showed that a 5-sec. period produced the best results, but the surge was still 100% above normal pressure. After further tests, a 10″ surge relief valve was installed on each of the three pump discharge lines (one of which was 48″, the other two 36″). These surge suppressor valves are of the hydraulically operated, rotary plug type manufactured by the Automatic Cone Valve Co. (a division of the Chapman Valve Co.). Set for a 2-second opening and 2.5-minute closing, these "entirely eliminated water hammer or surges."

Wells for municipal supplies in Missouri must be drilled under specifications prepared by the State Board of Health and State Geologist.[DD7-2] Contractor must notify latter one week before drilling is started, send him samples of soils encountered and report all information concerning openings, fissures or soft or broken ground. From these data the State geologist and engineer determine depth to which casing must be sunk to exclude water of recent surface origin, and representative of the geologist supervises the sealing of the casing and checks its tightness.

Precipitation cycles have been studied by the U. S. Weather Bureau[E8-5] and no confirmation found for either 11-year, 23-year or 35-year cycles. Of thousands of records studied, there were more departures from each of the suggested laws than correspondences with it; that is, forecasts of precipitation (and of temperature) made on the basis of any of the cycles would be wrong more than half the time.

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

B 8 *Journal, New England Water Works Association*
June
1. The Cobble Mountain Power Tunnel. By Harry H. Hatch, pp. 123-146.
2. Boston Metropolitan Water Supply Extension. By Karl R. Kennison, pp. 147-250.

D 8 *The Surveyor*
June 29
1. Consumption, Misuse and Waste of Water. By John Bowman, p. 696.
2. The Chlorination of Water Supplies. By P. S. Lelean, p. 698.
3. The Drought in England. By Thomas Paris, p. 701.

July 6
4. *n.* Sterilization of Drinking Water Supplies, p. 6.

E 8 *Engineering News-Record*
June 28
1. *c.* Large Derricks Supplement Cableways on Boulder Dam Work, pp. 832-833.
2. Engineering Aspects of the Present Midwest Drought, pp. 834-835.

July 12
3. Twelve-foot Precast Concrete Pipe for Little Morongo Siphon (Los Angeles). By Richard B. Ward, pp. 33-35.
4. Norris Dam Design Modified to Meet New Requirements, pp. 44-45.
5. Study of Weather Records Fails to Reveal Long-Range Cycles, pp. 46-47.

F 8 *Water Works Engineering*
June 27
1. Pipe Line Moved by Ice Floe. (Raritan, N. J.). By Chas. F. End, pp. 708-709.
2. Experiments in Pipe Corrosion. By Frank E. Hale, pp. 710-714.

July 11
3. Basis for Water Service Charges. By C. Kelsey Mathews, pp. 762-764.
4. Experiments in Pipe Corrosion. By Frank E. Hale, pp. 764-770.
5. Purification Problems Resulting from Pollution by Mine Waters. By Edward C. Trax, pp. 774-775.
6. Chart for Quick Calibration of Dry Feed Machines at Plant. By Everett C. Handorf, pp. 775-776.
7. Responsibility of Water Officials for Potability of Water Delivered. By L. R. Howson, pp. 783-784.
8. Effective Utilization of Public Water Supply in Fire Fighting. By W. C. Mabee, p. 787.

J 8 *American City*
July
1. Starting Operations of Water Purification Plant of Marion, Ky. By Jack J. Hinman, Jr., pp. 37-40.
2. Cicero, Ill., Bureau of Water Carries Its Case to the Consumer, pp. 48-52.
3. Water Rates, Service Charges, Installation Charges, Hydrant Rentals, pp. 63-65.

L 8 *Civil Engineering*
June
1. Boston's New Metropolitan Water Supply. By Frank E. Winsor, pp. 283-287.
2. Concrete for Madden Dam. By Irwin E. Burks, pp. 288-292
3. Constructing the Bouquet Canyon Pipe Line. By H. A. Van Norman, pp. 306-310.

July
4 *t.* Influence of Temperature on Coagulation. By Clarence J. Velz, pp. 345-349.

M 8 *Canadian Engineer*
July 3
1. *t.* How Water Flows in a Pipe Line. By Charles M. Allen, p. 6.
2. *t.* Water Gauging for Kaplan (turbine) Units of High Capacity at Safe Harbor (Baltimore). By J. M. Mousson, pp. 7-8, 10.

P 8 *Public Works*
July
1. Supplementing Underground Water Flow, pp. 11-12.
2. *n.* Laboratory Supervision Prevents Tastes and Odors, p. 35.
3. A. W. W. A.'s Successful Convention, pp. 40, 42-44.

S 8 *Construction Methods*
April
1. *c.* Construction Plan Adopted for Norris Dam, pp. 32-33.

May
2. *c.* Submarine Intake—30-inch Steel Pipe with Bolted Joints, p. 31.
3. *c.* Reservoir Area Supplies Fill for Rolled Earth Dam, pp. 36-37.

XX 8 *The Water Tower*
July
1. Welded Steel Pipe Fabricated for Owyhee Siphons, pp. 6-7.

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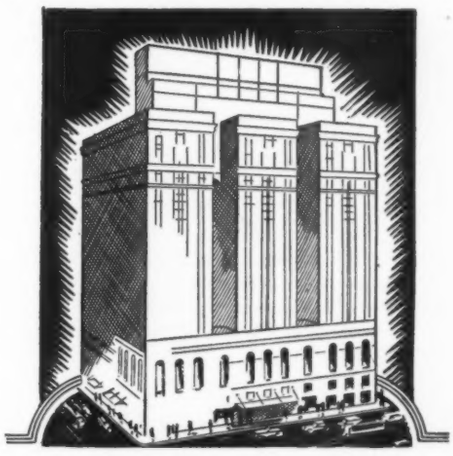

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News of the Engineering Field

Walter M. Smith, acting chief engineer of the Division of Waterways, State of Illinois, has been appointed chief engineer of that division.

Joshua D'Esposito has been appointed as resident engineer of the Chicago Sanitary District PWA sewerage construction job. Mr. D'Esposito was formerly state PWA engineer for Illinois, from which position he resigned to accept the above appointment. C. M. Osborn has been appointed State PWA Engineer. He was formerly village engineer of Wilmette, Ill., and is a graduate of Case School.

Austin T. Byrne died in Newburgh, N. Y., May 24. Mr. Byrne was for many years prominent in highway construction, and was the author of several books on the subject. He acted as chief of the engineering staff which, after the war with Spain, constructed the sewerage system for Havana, Cuba. Mr. Byrne had been a subscriber to PUBLIC WORKS since 1905.

William Hoskins, one of the pioneer chemical engineers of Chicago died recently at his home at LaGrange, Ill.

Benjamin J. Curtis, commissioner of streets and electricity of Chicago, died May 19, at his home in Chicago.

L. S. Hamaker, Sales Promotion Manager of Republic Steel Corporation, Youngstown, Ohio, has been advanced to the position of Vice-President and General Manager of The Berger Manufacturing Company, Canton, Ohio, wholly owned subsidiary of Republic, effective June 1.

R. S. Archer has joined the staff of the Republic Steel Corp., as chief metallurgist of the Chicago District. Previously, Mr. Archer, who is a graduate of the University of Michigan, had been associated with the A. O. Smith Corp., Milwaukee, and the laboratories of the Aluminum Company of America.

A. A. Ainsworth has been appointed by National Recovery Administrator Hugh Johnson as code authority for the water meter manufacturing industry.

Stanley A. Knisely, of Cleveland, has been appointed advertising and sales promotion manager of Republic Steel Corporation, with headquarters at Youngstown, Ohio. He succeeds L. S. Hamaker who was recently made vice president and general manager of the Berger Mfg. Co., Republic subsidiary, of Canton, Ohio.

Frederick Salditt has been appointed manager of the Export division of the Harnischfeger Corp., Milwaukee, Wisc.

Harlowe Hardinge, Vice President and General Manager of Hardinge Company, Inc., York, Pennsylvania, has recently returned from Europe, where he has been actively engaged in handling matters in connection with the foreign interests of the company. He reports business in England as excellent—up to that of 1928 and 1929.

Edmund Kearsley Swigart died on July 7th at Ballard Lake, Vilas County, Wisconsin, as the result of a heart attack. Mr. Swigart was born in Bucyrus, Ohio, on April 16, 1867. He joined Bucyrus-Erie Company in 1891 and was made Secretary and Treasurer of that Company in 1901. In 1910 he was made a Joint Managing Director of the Company, and in 1911 Senior Vice President, a position which he held until his death.

Col. Henry M. Waite has resigned, effective September 1, as Deputy Administrator of the Public Works Administration to accept an important post with the City of Cincinnati. He will take charge of the Department of Economic Security, an organization designed to cope with unemployment and rehabilitation problems, which is sponsored by the City of Cincinnati, Hamilton County and the Spelman Foundation.

Alphonse E. Brosky has been appointed Special Engineer by the Jeffrey Manufacturing Co., Columbus, O. To accept the post, Mr. Brosky has resigned as consulting editor of *Coal Age*.

Dwight L. Hoopingarner and F. J. C. Dresser have been appointed Associate Directors (advisory) of the Public Works Administration Housing Division. They will aid in developing the low-cost housing and slum clearance program.

Twelve Army and Navy officers who were assigned to emergency detail with the Public Works Administration have been recalled and their work will be carried on by civilian PWA engineers and staff. These men served under the direction of Major Robert W. Crawford (Engineer Corps, U. S. A.), who was Director of the Project Division of the PWA. Besides Major Crawford, Director of the Projects Division, the officers loaned to PWA by the services and now recalled to service duty were:

Lt. Comdr. F. J. Gaffney (S.C.), USN, expediter for New England and the Middle Atlantic States; Lt. T. F. Darden, Jr., USN, expediter for the South Eastern States; Lt. F. J. Dau, USA, field expediter; Lt. Comdr. R. G. Tobin, USN, expediter for the Mid-Western States; Lt. Comdr. M. M. Smith (S.C.), USN, expediter for Mid-Western States and field expediter; Capt. R. H. Elliot, USA, expediter for the Southern States; Lt. H. Twichell, USA, expediter for Mid-Western States; Capt. H. O. Tunis, USA, expediter for South-Western States; Lt. Comdr. C. Schaaf (S.C.), USN, expediter for Rocky Mountain States; Lt. Comdr. C. W. Stevenson (S.C.), USN, expediter for Mid-Western States; Capt. H. A. Skerry, USN, field expediter for the Pacific Coast States.

Appointment of a combined local and Federal committee to determine the best site for a great central airport for Chicago has been announced by Public Works Administrator Harold L. Ickes. Nominated by the Chicago Aero Commission (with the consent of Mayor Kelley) were two members, Hunt Wentworth and Merrill C. Meigs, who is Chairman of the Aero Commission, both of Chicago. Nominated to represent the Government were: Mrs. Kellogg Fairbank of Chicago; F. J. C. Dresser of the Public Works Administration, and Henry Porter Chandler of Chicago.

Western-Austin Officers Elected

At a meeting of the stockholders on June 21st of the Austin Manufacturing Company of Harvey, Ill., and the Western Wheeled Scraper Company of Aurora, Ill., consolidation of the two companies to form the Western-Austin Company was officially approved.

The Austin-Western Road Machinery Company will continue to handle sales for the new corporation, and the home office of both companies will be at Aurora, Ill.

The newly elected officers of both companies are as follows: C. W. Sencenbaugh, *Chairman of the Board;* S. F. Beatty, *President;* H. B. Bushnell, K. N. Forbes, F. L. Jerome and H. M. Kleiser, *Vice Presidents;* J. L. McNab, *Secretary;* McClure Kelley, *Treasurer.*

According to S. F. Beatty, president of the new corporation, operating economies, increased efficiency, and improved service to Austin-Western customers will result from the consolidation.

A district sales office under the supervision of E. J. J. McGinty will be maintained in Chicago at 105 W. Adams St.

Material Prices

(Published for information only.)

(July 23, 1934)

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$47.50	Baltimore	$45.50
New York	44.90	Atlanta	42.00
Chicago	46.00	Birmingham	38.00
Minneapolis	48.50	Kansas City	48.15

Burlington, N. J., $42.00; extra price for 4-inch, $3.00 per ton; extra for Class A, $3.00 per ton.

**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bars*
New York	3.37c	—
Boston	3.42	—
St. Louis	3.44	—
Cincinnati	3.45	3.10
Pittsburgh	3.15	2.90
Chicago	3.20	—
Philadelphia	2.95	2.955
Cleveland	3.31	2.10*
San Francisco	3.55	3.50

**Plus extras*

Warehouse Prices on American Pig Lead

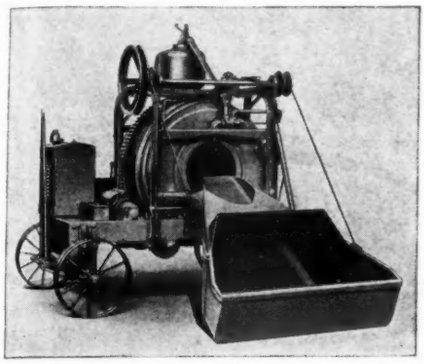
Per pound

New York	4.50 to 5.50
Cleveland	4.85 to 5.10

Recent Developments in Construction Equipment

A New "Dandie" Mixer:

To meet present-day construction requirements, the new 14-S Dandie mixer employs high-strength alloy steel, resulting in the exceptionally light weight of 4,975 pounds, and is equipped with full spring mounting, Keohring automatic skip flow shaker (which shakes the skip up and down in the natural flow line), a short wheel base, and a turning radius of 16 feet. The new syphon type of water measuring tank measures accurately any amount, from 5 to 27 gallons, to the fraction of a pint. Other advantages are anti-friction bearings, V-belt drive, and ability to discharge the mix in eight seconds. An attractive and complete folder will be sent on request to National Equipment Corp., N. 30th St., and Concordia Ave., Milwaukee, Wis. This new mixer is equally suitable for bridge and culvert work and general construction.



New 14-S NEC Mixer

New C-1 ½-ton International

In the design of the new Model C-1, ½-ton six-cylinder International motor truck, special consideration has been given to the ever increasing demand for pleasing lines and color combinations. A sloping V-shaped radiator with polished stainless steel molding and satin-finish aluminum grille, deeply crowned and valanced fenders, streamline hood and cowl all help to make this new C-1 a most attractive-looking light hauling unit. The wheelbase of 113 inches is especially suited for light delivery bodies, while the engine develops 78.5 maximum brake horsepower at 3400 r.p.m.

"X" Marks the Spot . . .

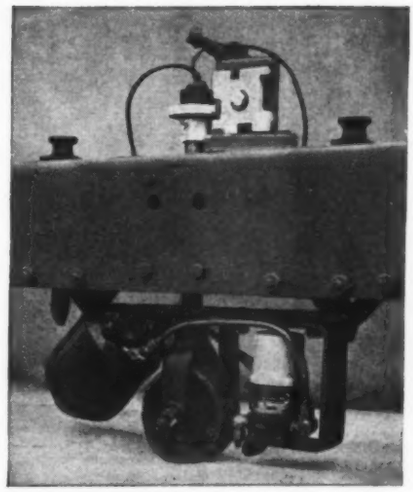
A unique application of a normally-closed solenoid operated valve has been made on a road surface tester, the purpose of which is to locate the high spots and depressions beyond allowable limits on newly laid roads.

This tester, manufactured by the H. and H. Manufacturing Company of Elyria, Ohio, consists of a framework on wheels on which is mounted a free-moving roller with an extension arm, constructed so that the roller with its extension arm can follow the profile of the road independently of the truck wheels.

The upper part of the extension arm is arranged to establish a contact if the roller moves in either direction beyond permissible limits. Whenever this contact is made, the G-E solenoid valve, which is mounted on the frame, is energized, opens and squirts a stream of marking fluid on the defective spot.

½-ton International Truck

The contact established by the extension arm also lights an indicating lamp on the upper part of the road tester so that the crew foreman may make a preliminary inspection of the defective spots as the tester moves over each section of the road. The lamp and the solenoid valve are operated from a 6-volt battery on the tractor which pulls the tester.



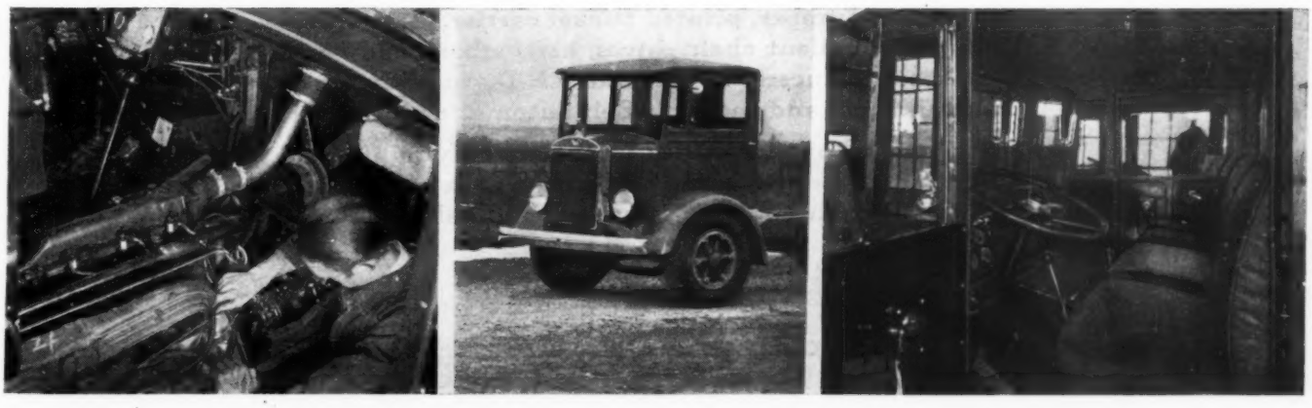
For locating high spots in pavements

Asphalt Mixers:

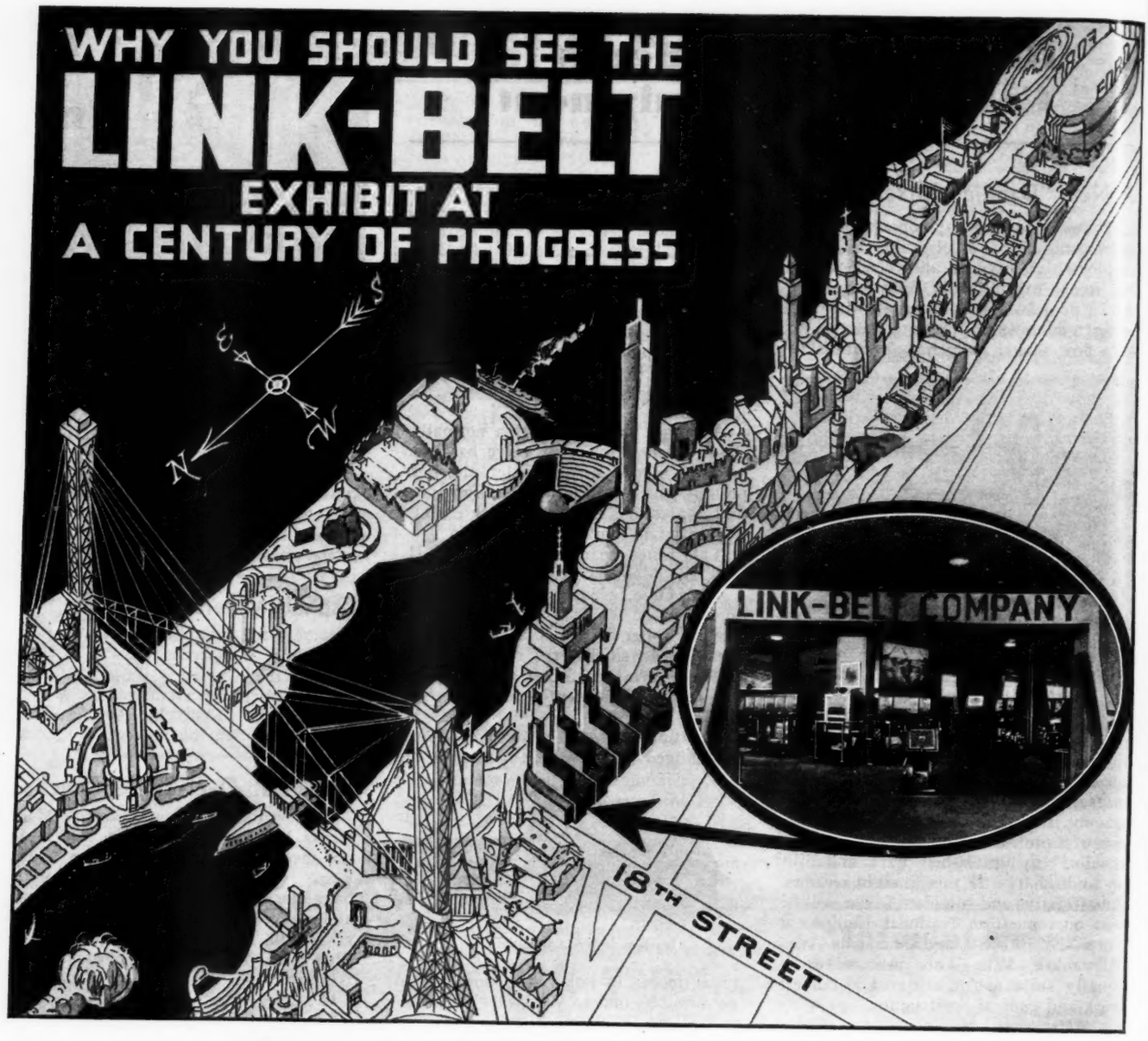
Mixers for bituminous paving of all types, and in capacities of 400 to 4000 pounds are described in Bulletin M-234, recently issued by Hetherington & Berner, 701-745 Kentucky Ave., Indianapolis, Ind. Sent on request.

Mack Cab-Over-Engine Trucks

A new line of the well-known Mack trucks have been announced, which do not much resemble the familiar "bull dog" front of the Mack. These units have the cabs located over the engine, and as a consequence, have a much shorter length, boast a shorter turning radius, and provide a better weight distribution. On the same tires, the new CH Model, rated 3 to 5 tons, can carry 1100 pounds more than its conventional counterpart, while the CJ, rated 3½ to 6 tons, will carry 1200 pounds more than its older mate. Gross weight ratings are about 5% greater. Easy accessibility of the engine and engine parts is a factor in better maintenance. Mack Trucks, Inc., 25 Broadway, N. Y., will send details on these new units.



Three views of the new Mack showing engine accessibility, general appearance and the roomy cab



BECAUSE there you will see modern cost reducing conveying and positive power transmitting methods and equipment realistically portrayed. Brilliantly illuminated dioramas depicting engineering installations; translites (illuminated color photographs) of conveyor installations; working models of a crawler dragline, rotary railroad car dumper, pivoted bucket carrier. Also operating units of silent chain drives, herringbone and worm gear speed reducers, P.I.V. and V.R.D. variable speed transmissions, and the Link-Belt automatic coal stoker.

To anyone who is interested in the art of handling and preparing materials, and the transmission of power, a trip through this exhibit is an educational experience.

LINK-BELT COMPANY 5067

Leading Manufacturers of Equipment for Handling Materials Mechanically and Transmitting Power Positively

INDIANAPOLIS CHICAGO PHILADELPHIA SAN FRANCISCO TORONTO

Offices in Principal Cities

WE INVITE YOU to make your headquarters at the Link-Belt exhibit, located in the General Exhibits Building, at the 18th Street entrance, in Pavilion No. 1. Chicago—to Nov. 1, 1934.

For latest industrial literature, consult the *classified* READERS' SERVICE DEPT.—pages 47-49.

For Better Highway Maintenance

Traffic Lines at .006c Per Foot

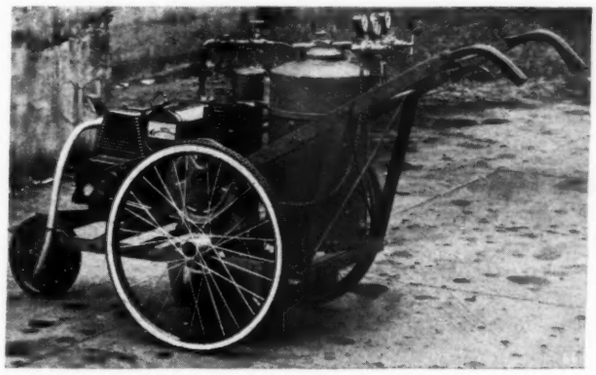
The traffic line marking machine of the Simons Paint Spray Brush Co., Dayton, Ohio, will produce a selective line from 3½″ to 6″ wide as rapidly as the operator will walk.

The wheels on the main axle, with the guide wheel in front and the spray nozzle located at a point directly under the main axle, enables the operator to hold the machine with a surprising degree of accuracy for producing the straight line on the pavement or floor.

The location of the pavement cleaner emphasizes its importance for the reason that the surface of the pavement, and all the cracks and crevices in it are effectively cleaned just prior to the spraying operation. That very essential detail cannot be accomplished by any broom or revolving brush. The clean pavement is necessary for greater adhesion of the paint which means longer wearing resistance from the traffic.

The entire apparatus is a complete power plant having an air cooled gasoline engine, "V" belted to the compressor from which the air is stored in a suitable reservoir.

Reports received by the company, and carefully checked, indicate that the outfit, with reasonable care and a maintenance charge of about $4.00 per annum, will serve for about fifteen years. The average cost of producing a 5″ line, all items of expense taken into the account, is about .006c per lin. ft.



Simons Traffic Line Marker

The Champion Chip Spreader

The Good Roads Machinery Corp., Kennett Square, Pa., has just issued their Bulletin No. 51 showing and describing the "Good Roads" Champion Chip Spreader. This machine will spread stone chips, cinders or sand as desired, and is particularly useful in the sanding of slippery hills and curves during the winter season. Attachment is made to any standard truck through patented quick-acting clamps. This is the quickest coupling device for chip spreaders thus far developed, it is said.

The quantity of material applied is regulated or entirely shut off as desired. The rotating spinner disc is a steel casting, ribbed and extremely durable. Wheels are so placed that the material being spread does not strike the wheel, thus preventing sticky material from "building up" on face of wheels. Steel wheels, or steel wheels with solid rubber tires are furnished.

When operated on the outside of the road, the deflector plate on the outside is lowered to prevent material from going into the gutter. The opposite deflector plate is raised to spread the material as far towards center of road as possible, thus giving the desired distribution.

Spreads Stone Chips and Sand Evenly

Heavy cutting on a slope with the Centaur Mower

Total Cost 35c per Mower Mile:

Cost data have been collected on the Centaur Hi-Way mower which show a total cost, including labor, interest and depreciation, fuel, lubrication and repairs of 35 cents per mower mile for highway mowing. The average on 635 miles of operation showed 2.14 miles per hour worked. These figures are based on mowing operations on state highways, under state specifications.

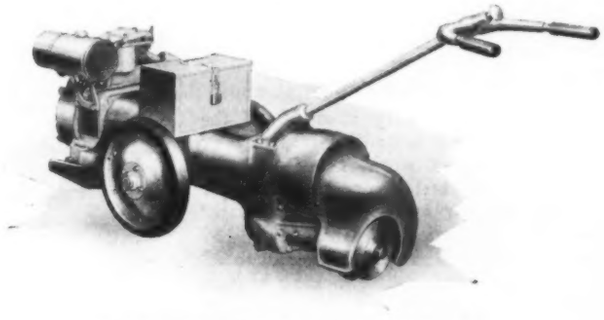
The Centaur mower is designed to cut in close quarters, in tough vegetation, on steep slopes and at any angle from 30° up to 30° down.

In 20 minutes this mower can be converted into a road drag or into a snow plow unit. Three excellent folders are available from the Centaur Tractor Corporation, Greenwich, Ohio.

To Smooth Rough Concrete

A machine designed to cut concrete surfaces has been brought out by the American Floor Surfacing Machine Co., 531 South St. Clair Street, Toledo, O. It is especially valuable in smoothing high spots and bad joints in concrete highways. It is reported that on one 3 mile section of concrete, 172 bumps, ranging from small to large, were ground down in 14 hours with the cutters good for another 28 hours. Another bad joint, involving an area 7 feet by 17.5 feet, where the straight edge showed a 2-inch variation, was ground down in 45 minutes.

A dust collecting unit is built in, which removes the concrete dust so that the cutting head is always working on a clean surface. Shipping weight 750 pounds; net weight 650 pounds. Driven by a 5 hp. air cooled gasoline engine. Description on request.



For Smoothing High Spots in Highways

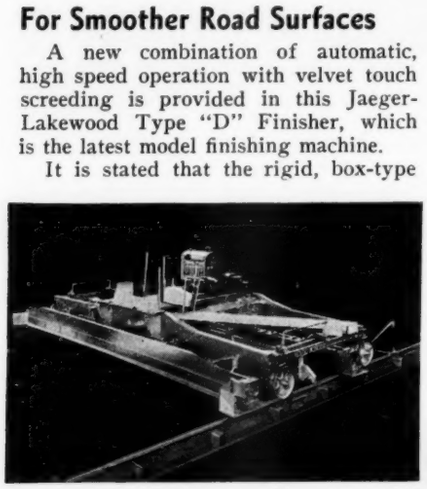
For latest industrial literature, consult the *classified* READERS' SERVICE DEPT.—pages 47-49.

Finishing Devices Assure Smooth Riding Surfaces

For Smoother Road Surfaces

A new combination of automatic, high speed operation with velvet touch screeding is provided in this Jaeger-Lakewood Type "D" Finisher, which is the latest model finishing machine.

It is stated that the rigid, box-type



Jaeger "D" Finisher

12" screeds give a new roadability to concrete and bituminous surfaces and eliminate most of the costly hand work behind the finisher. Positive, automatic power lift raises and lowers the heavy screeds in 2 seconds. Each screed is independently controlled.

Higher working speeds of 8 and 12 ft. per minute forward and 40 to 90 ft. reverse, combined with automatic increase of screed strokes to a maximum of 36 cycles or 72 strokes per minute, give greater finishing capacity.

Jaeger-Lakewood Vibrating Attachment, mounted direct on screeds and used successfully on many jobs, is offered in combination with bullnose front screed.

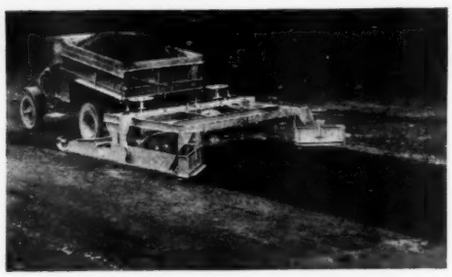
The standard Type "D" machine is furnished with 4-cylinder, 10-15 h.p. gasoline engine with flexible throttle control for intermediate speed ranges. The same machine is also built with gas-electric power, the engine and generator producing current for the operating motors with reserve power sufficient for extra load where vibrating attachment is used and also for operating lights when needed on the job. Bulletin 41-G, which describes the Model "D" in detail, has just been issued by The Jaeger Machine Company, Columbus, Ohio, the manufacturer.

Bolser Nestable Flares

One man can carry 8 or 10 of the Bolser flares for guarding highway or other construction work. These are nestable, with a quarter turn of the wrist, saving 75% or more of storage space. Built of 20-gauge steel; capacity 4½ pints of kerosene; burning time 28 to 32 hours. The nesting and locking system makes extinguishing and picking up hot flares easy. These flares, and also truck, bus and trailer flares, are made by the Bolser Corporation, 9th and Murphy Sts., Des Moines, Iowa.

Vibrating Spreader-Finisher for Secondary Roads

A screed vibrated at 3,500 r.p.m. for vibratory spreading, striking off and finishing; 15-ft. long "straight-edge" sled runners, which act as forms, equalize high spots and smooth the surface; and a telescoping main frame used in combination with screed extension wings to give 9 to 14 ft. width adjustability—these are some of the features of the Vibro-Spreader which The Jaeger Machine Company



Jaeger Vibrating Spreader-Finisher

has developed for laying secondary roads.

The machine spreads gravel, rock, slurry, armor plate, macadam and hot or cold bituminous mixes—leveling, binder and top course—any width from 9 to 14 ft., any thickness between 1 and 8 inches. On 2- and 3-lane work the clean-up or flushing wings insure proper blending of strips and uniform density.

The vibration of the screed, which is also imparted to the sled runners, keeps materials plastic and the load "alive," reducing draw-bar pull and making possible much faster spreading, it is stated. Once over with the Vibro-Screed places rock. Macadam and bituminous mixes, hot or cold, are placed ready for rolling as fast as they can be fed.

The Bolser Flares; at right, nested.

Outline view of Jaeger Spreader-Finisher

In addition to the smoother surface, due to the long sled runners, this increased speed and capacity offer the advantage of real job savings, according to the manufacturer. Bulletin BS-34, issued by The Jaeger Machine Company, Columbus, Ohio, describes the machine in detail.

Blaw-Knox Gas-Electric Road Finisher

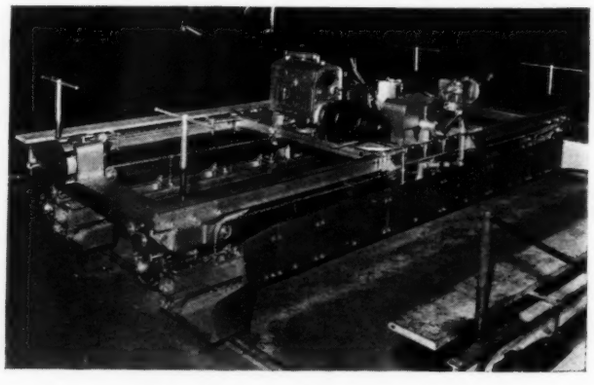
Blaw-Knox Company, Pittsburgh, Pa., has developed a road finisher for concrete and bituminous paving, which is fully electrically powered, power being furnished by a generator direct connected to a gasoline engine which is mounted on the machine. This finisher has four speeds forward and four speeds reverse. Traction is equal on all four wheels, providing sufficient power under full load for maximum grades.

The machine has finger tip control, without exertion on the part of the operator, who is enabled to watch more closely the actual finishing rather than the mechanics of machine operation.

A minimum of time is required to change the machine width, which can be adjusted by inches. The crown adjustment can be quickly made, and the simply designed screeds are electrically operated. Traction can be adjusted to handle varying loads and consistencies of concrete. Jacks for elevating and lowering the finisher are built into the machine.

The finisher is equipped with automatic brakes. It has no clutches and is easily steered. Job stoplighting is another feature on the machine. It is designed for the addition of vibrating attachments, tampers, and all accessories for bituminous paving. It is equipped throughout with bronze bushings and roller bearings.

Complete information on this machine can be secured from the Blaw-Knox Company, Pittsburgh, Pa.



Blaw-Knox Gas-Electric Finisher

Pipe, Cast Iron

407. New 1934 Handbook of Super-detables and data for the water works man on pipe line construction, weights, and dimensions. 40 pages, handy pocket size. United States Pipe & Foundry Co., Burlington, N. J.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Taste and Odor Control

411. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

412. Cliff-Char, a Superior Activated Carbon, for Water Purification. Exceptionally high in phenol adsorption, deodorizing power, taste adsorption, clarifying power. Full information will be sent by Chemical Dept., The Cleveland-Cliffs Iron Co., Union Trust Building, Cleveland, Ohio.

Pumping Engines

413. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

417. The simple, automatic Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

419. An illustrated booklet showing installations, and complete details regarding the 19 exclusive improvements which are featured in Shevlin Fine Disc Screens will be sent promptly by the Shevlin Engineering Co., Inc., 227 Fulton St., New York, N. Y.

420. A useful new bulletin for all those interested in sewage disposal, describing some of their proven equipment such as self-cleaning bar screens, grit conveyors, sludge collectors and shredders, has just been issued by the Jeffrey Mfg. Co., Columbus, Ohio. Includes diagrams and many illustrations.

Screens

424. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sludge Bed Glass Covers

426. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Main Office, Elizabeth, New Jersey. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Conditioning

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

Treatment

429. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

430. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

431. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

433. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

Road and Street Maintenance

Asphalt Heaters

8. Full information concerning their tar and asphalt kettles, surface heaters, oil burners and other road maintenance equipment will be sent promptly on request by Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

200. For general construction and maintenance, the Original Improved "Hot-stuf" Asphalt Heater, an economical oil burning heater. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Bituminous Materials

225. A comprehensive manual on the "Use of Emulsions for Street and Highway Construction and Maintenance," discussing types, uses, relative costs, construction details, etc., will be sent promptly on request by Headley Asphalt Division, Sinclair Refining Co., P. O. Box 72, Marcus Hook, Penna.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which may be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

227. "Asphalt for Every Purpose," a 44-page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvialithic. 32 excellent illustrations.

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Ave., New York, N. Y.

229A. Surface Treatment Types, Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute, 801 Second Avenue, N. Y. Sent on request.

STREET, SEWER AND WATER CASTINGS

Made of wear-resisting chilled iron in various styles, sizes and weights

MANHOLE COVERS, WATER METER COVERS, ADJUSTABLE CURB INLETS, GUTTER CROSSING PLATES, VALVE AND LAMPHOLE COVERS

Write for Catalog and Prices

SOUTH BEND FOUNDRY CO.

All Kinds of Gray Iron Castings

SOUTH BEND, IND.

Index to Advertisements

For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Laundry Waste Treatment:

"The Treatment of Laundry Wastes" by J. A. Boyer, Bulletin No. 42 of the Texas Engineering Experiment Station, A & M College, College Station, Texas, has recently been issued. The objectionable character of laundry wastes is given and the difficulties arising from discharging such wastes in the sewers are indicated. The experimental work included treatment of the wastes with chemicals and oxidation by filtration. Of the chemicals used, ferric chloride was most satisfactory, but adjustment of the pH of the waste to 6.6-6.4 with sulphuric acid was essential for economical treatment. Biochemical oxygen demand was reduced 85 to 90 per cent and a clear, stable effluent resulted. A trickling filter 6 feet deep was operated over a five-months' period at various rates. At a rate of one million gallons per acre per day 75 per cent reduction in biochemical oxygen demand was obtained. The effluent was stable enough to discharge into a stream. The Dunbar filter was found to be less efficient than the trickling filter in treating laundry wastes. It is concluded that, considering operating difficulties and costs, the use of the trickling filter is preferable to chemical treatment.

Vibration in Concrete Placement:

An excellent booklet of 32 pages has been issued by the Portland Cement Association, 33 West Grand Avenue, Chicago, Ill., covering this method of placing concrete. Contents are: What is vibrated concrete? Vibration equipment. Test data. Proportioning for vibration. Recommended practice. Bibliography. A list of manufacturers of vibrating equipment is furnished.

The First 453 NRA Codes:

The National Recovery Administration has compiled a chart which lists in alphabetical order all codes approved up to early May, 453 in all. The addresses of Code authorities are given. Copies from National Recovery Administration, Trade Association Section, Washington, D. C.

Summer Courses in Public Health:

The summer courses in public health given at Rutgers University by the New Jersey State Department of Health are outlined in full detail, covering 6 hours of instruction daily for 6 weeks. Public Health News, Department of Health, Trenton, N. J.

Work Relief in Germany:

General policies as to wages and hours, personnel practices, planning and selection of projects, types of projects, special projects for women and others, transient service, work-for-wages and work-for-relief are all discussed in this 93-page book by Bertha Kraus. Published by Russell Sage Foundation, New York, N. Y.; price 50 cents.

The Typhoid Carrier:

An interesting article on this problem appeared in the Ohio Health News, June 1, 1934. Copies from the State Board of Health, Columbus, Ohio. Another complete article on the same subject in "Health News" New York State Department of Health, Albany, N. Y., (July 2 issue).

Small Sewage Works Apparatus:

Two small bulletins, each of 12 pages, have been issued describing "Lath Filter Sewage Treatment Plant Design" and "Small Rotary Distributors." These are pretty good for the designer of the small sewage treatment plant, as some details are given that are hard to find elsewhere, though the booklets are not complete. Some interesting dope on design of treatment plant for milk waste, based on 6400 gallons of waste per day. These can be obtained from R. D. Simpson Co., 136 East Gay St., Columbus, O.

Blasting Knowledge:

A long list of questions and answers on methods and data on the use of explosives for blasting ditches, boulders and stumps. 8 pages. Free on request to the Editor of PUBLIC WORKS.

Lubricants:

"Extreme pressure lubricants for heavy duty trucks" is the title of a 20-page booklet prepared from the exhaustive studies on this subject by J. Sorenson, FWD metallurgist. Not technical, but valuable to heavy duty truck owners. Write the FWD Co., Clintonville, Wisconsin.

How to Maintain Roads:

This 56-page booklet is devoted largely to the problems involved in the maintenance of roads of the gravel and traffic-bound types. It contains data and information for everyone who has the problem of maintenance of such surfaces. It gives a good deal of information on stabilized roads. This edition, just out, is entirely rewritten from original material, and is a very worthy successor of preceding editions. It considers city streets as well as country highways. Excellent illustrations. Engineers' tables. Available on request from Dow Chemical Co., Midland, Mich.

Gate Valves:

A new bulletin explains the Kennedy "Newtype" water gate design in detail, showing a sectional view of the valve and the complete specifications and dimensions. Various methods of operation and special arrangements are also described and illustrated. These valves conform with specifications of the American Water Works Association in all respects and are built in sizes from 4 in. to 12 in. for 200 lb. working water pressure, and in sizes from 14 in. to 60 in. for 150 lb. working water pressure. Copies from The Kennedy Valve Manufacturing Company, Elmira, New York; ask for Bulletin 32.

Black and White "Blue Prints":

A new development in reproductions of drawings. Black lines are obtained quickly. Process appears simple. Fuller data from Charles Bruning Co., Inc., 102 Read St., N. Y.

Better pH Control:

This 24-page booklet describes a full line of pH comparators employing permanent, non-fading glass color standards. In addition to this, there is some useful information on the determination of hydrogen ion concentration. Sent free on request to Hellige, Inc., 179 East 87th Street, New York City, N. Y.

Blasting Ditches:

Recently developed methods of ditch blasting, along with standard practices which have been in use for years, are fully and clearly described in a 48-page booklet which has been published by the E. I. du Pont de Nemours Co., Wilmington, Del. It contains working information on the use of dynamite for ditch blasting, the methods of making and maintaining ditches, etc., and definite data on the marked progress in the use of explosives in this line of work.

Speed Reducers:

32-page catalog (No. 1415) with horse power and other engineering data, dimension diagrams, etc., of single, double and triple reduction units of herringbone gear type; also flexible couplings. Link-Belt Co., Philadelphia, Chicago, San Francisco.

Trend Toward Bituminous Types:

A 4-page folder issued by the Asphalt Institute, 801 Second Ave., N. Y., which presents data from official and Institute sources on the present-day trends in pavement types.

Tube Couplings:

Parker Tube Couplings are described in Bulletin 35, put out by the Parker Appliance Co., Cleveland, O. This bulletin stresses the importance of *planned* industrial plumbing to assure economical and satisfactory installations. To encourage this a series of dimension sheets in loose-leaf form, with a durable and practical binder will be published shortly. These contain sufficient data so that accurate layouts can be made. Dimension sheets do not appear in Bulletin 35, and are sent only on request without cost. Bulletin 35 contains 36 pages and much information for engineer, draftsman and installer.